RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

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Richard H. Chamberlain, M.D.
Carman Lecturer, 1952

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Vol. 60 MARCH 1953 No. 3

The Place of Physics in Clinical Radiology

The Carman Lecture[1]

RICHARD H. CHAMBERLAIN, M.D.

Philadelphia, Penna.

THE TRADITIONS of this tribute to Dr. Russell D. Carman have been to keep alive the spirit of devotion to our work in radiology for which he set so high a standard in his personal life. My own impressions of his stature have, of necessity, been derived through intermediary sources, for my adventures into medical education date only from the year of the first lecture in his memory before the Radiological Society of North America. It is all the more remarkable, however, that the example which he gave should be so vivid in transmission. Perhaps the subject of consideration in this essay was not one of his particular interests, but I am told that he was in the habit of personally attending the operative procedures on the patients whose roentgen examinations he had performed, in order to correlate his observations with the anatomical and pathological findings. Such a spirit of personal and meticulous attention to the integration of radiology with associated fields is precisely the theme to which I would like to call your attention. It is more important in defining the place of physics in clinical radiology than the enumeration of instances for useful cooperation. In the advances of scientific knowledge, the facts of today may be supplanted by the findings of the morrow, but the preceptor who inspires dedication to standards of excellence and breadth of scope in understanding is eminently fit to be our point of reference.

No other branch of medicine owes so much to contributors from associated scientific fields as does radiology. From its very inception in the work of Roentgen, the Curies, and Becquerel, a pivotal point of this interrelationship has been in association with physics. It may not be so obvious, however, that the growth of radiology has been marked by constant interchanges and cross contributions from physicists at every stage. This is the twentieth anniversary of the remarkable year in which H. C. Urey discovered deuterium, Chadwick discovered the neutron, and E. O. Lawrence invented the cyclotron. At that time, these may have seemed to be rather abstruse theoretical developments in physics, but they culminated in the self-sustaining nuclear chain reaction which first occurred on Dec. 2, 1942. So, almost to the day, this is the tenth anniversary of that milestone of physics which has changed the face of world events. In addition to this significance, which is reason for our physicist friends to date their calendar from it

[1] Delivered before the Radiological Society of North America at the Thirty-eighth Annual Meeting, Cincinnati, Ohio, Dec. 9, 1952.

From the Department of Radiology, University of Pennsylvania and Hospital of the University of Pennsylvania, Philadelphia, Penna.

to the extent of considering this as the beginning of the eleventh year of the slow neutron, it has also determined new trends in the future of radiology. From these events stems the availability for medical research and clinical application of the resources of radioactive isotopes in quantity and variety. But the importance of physics in radiology is not defined by episodes of major distinction; it is derived, rather, by our applications of the whole scope of physical phenomena.

It is appropriate to do honor to the liberal vision of a large group of pioneers who have assimilated the advances in physics and reinterpreted them to practical use. Many of these have been radiologists, stimulated by the problems arising in their practice. As the complexity of basic material has increased, an unusual group of radiological physicists has become devoted to this endeavor and has been the major factor in this translation. These expositors of physics have been a truly international group, although in certain places an unusual and remarkable development has occurred, as for example in therapeutic radiological physics with the British group of Mayneord, Lamerton, Parker, and others who have so closely integrated their work with the therapeutic radiologists in that country. In America, too, we owe a great debt to radiological physicists. Particularly among these should be mentioned Failla, Quimby, Glasser, Weatherwax, Taylor, Weyl, and Warren, who have so patiently devoted their energies to writing and teaching for our enlightenment. As one of their students, there is a basic presumption in my addressing you on a subject that is in good part derived from their endeavors; yet it is more than appropriate that this appreciation of their efforts should be voiced by a clinical radiologist.

In presenting, in proper balance, the place of physics in clinical radiology, it is not fitting to over-emphasize the academic aspect of physics to the exclusion of clinical applications. There are intellectual values in such study for its own sake, but it is pertinent to the theme which I wish to express rather to define two principles of relevance. First, physics furnishes the thread of *basic understanding* which extends through all segments of radiology and makes it easier to absorb as a related whole. Secondly, the derivation of individual portions of this understanding furnishes the *method for application* to specific practical problems. It is in the light of these theses that physics can achieve its maximum value in integration with biological and medical considerations.

Perhaps one of the most serious barriers to the full use of physics in radiology has been the one of language. Mathematics is the special language of physics, and it is a matter of concern that, in the crowded curriculum of premedical and medical education, so few radiologists have the time or foresight to acquire proficiency in it. By the time that the physician reaches the level of clinical training in radiology there is even less likelihood that he will be able to recoup the lost opportunity. Capable efforts have been made to simplify portions of its mysteries for our special uses (1, 2), yet I can speak with personal feeling of the fact that it is a formidable task to become adept in its use. Fortunately, though mathematics is a shorthand which simplifies the transmission of complex ideas in precise terms, it is possible to translate these into words or graphic illustrations. It is to the credit of teachers of radiological physics that they have been willing to act as such interpreters. The situation might be considered analogous to that of the traveler in a foreign country whose visit might be enhanced by fluency in the native tongue, but who yet may have an enjoyable experience with moderate assistance from willing interpreters.

If it can be shown in the consideration of specific fields in radiology that these physical concepts can be understood, that they are vital and pertinent to clinical use, and that yet greater potentialities for advancement in radiology can be expected by their application, my enthusiasm for

directing your attention to this theme will be amply justified.

PHYSICS IN ROENTGEN DIAGNOSIS

From the physical standpoint, the shadows which are the medium for clinical interpretation in roentgen diagnosis are variations in densities within photographic emulsions or variations in the activation of fluorescent crystals. Furthermore, the production of x-ray photons in the x-ray tube and the laws which govern their transmission and alteration in passage through interposed objects also fall within the scope of physics. From this standpoint, the problems of roentgen diagnosis might be outlined as follows:

A. Radiation Sources
   1. Power Supply and Control
   2. X-Ray Tubes
   3. Geometric Aspects
B. Radiation Receptors
   1. Photographic Emulsions
   2. Fluorescent Receptors
      Phosphors
      Electronic Amplification
   3. Photofluorography
C. Physics of Interpretation

By far the greatest volume of effort of radiologists in the practical applications of physics has been in the perfecting of apparatus and technics for roentgen diagnosis. Toward the improvement of the instruments and their use have been directed the best talents of manufacturers of equipment, films, and screens. The majority of radiologists have availed themselves of the benefits thus derived with varying degrees of basic understanding and knowledge of the methods of application of physics involved. The radiologist presented with a given film may be able to arrive at a correct clinical interpretation, but, without physics, he will not be in a position to know how it can be improved or what limitations prevent him from extracting still further information from it. As Dr. J. E. Roberts has aptly expressed it (5), "a radiologist is better equipped professionally if he has an adequate knowledge of the weapons of his profession." He should also be sufficiently conversant with the technical aspects of his apparatus to direct his technicians and to exercise judgment in the purchase and maintenance of equipment.

Such judgments include the merits and limitations of the voltage and milliamperage range of power supplies, precision and dependability of timing circuits and meters, and factors influencing reproducibility of results. Physical principles form the basis for important advances such as the brilliant application by Morgan and Hodges of the principle of feedback to the control of exposures by photomultiplier tubes (6).

The gains of power capacity and definition with rotating anode tubes have been universally accepted, but the usefulness of tubes with yet finer focal spots will also be dictated by physical considerations. Geometric aspects influence the choice of optimal grid ratios and design, the employment of linear, circular, spiral, or rotation body-section apparatus, and the usefulness of teleradiography and telefluoroscopy. In spite of diligent application to these problems there are improvements yet to be made. The final test of all apparatus lies in its use for clinical problems, but much lost motion and fruitless argument can be avoided by the judicious employment of simple test objects and phantoms in objectively evaluating specific items of equipment.

Photographic emulsions as radiation receptors have been carried to a high state of perfection, but the products of all manufacturers do not show uniform characteristics. The radiologist can judge their quality by relatively simple physical tests on a sounder basis than by the eye alone. Of greater practical worth, however, is the control of development, for the stability of this procedure is essential if the other variables in radiographic technics are to be standardized. Physics as well as chemistry determines the precision necessary in development, and the procedures can be advantageously monitored

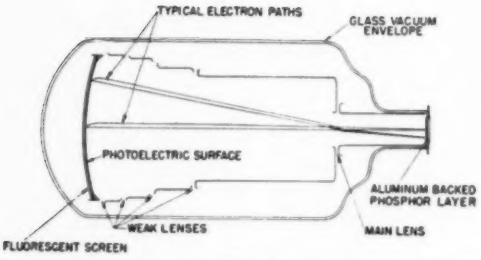

Fig. 1. Schematic diagram of Coltman amplification tube.

by densitometric control of test strips to insure uniform results (7).

Fluoroscopy is the diagnostic procedure which offers the best opportunities for significant progress. In the Carman Lecture of 1941, Dr. W. Edward Chamberlain presented the physical basis for study of the problems of fluoroscopes and fluoroscopy (8). This presentation was heightened by intuitive speculation with respect to future improvements, certain phases of which have been elaborated by Morgan and Sturm (9, 10), as well as others. The advantages of fluoroscopy in clinical diagnosis, with infinite choice of projections, observation of internal dynamics, and immediacy of presentation, are inescapable. We are now at the threshold of seeing the amplified fluoroscopic image become a practical tool for clinical use. Direct amplification as afforded by tubes of the Coltman type (11), schematically diagrammed in Figure 1, is already a clinical reality. Regardless of the limitations imposed in its present stage of evolution, this is a remarkable achievement, and past experience with commercial development of such apparatus would lead us to predict with confidence that yet further improvements will follow.

In the winter of 1949, Dr. Samuel Seal and I, working with engineers of the Radio Corporation of America, at the University of Pennsylvania, set up a television chain for amplification of the fluoroscopic image which, to my best knowledge, produced the first television amplification of human fluoroscopy. In this initial experiment we thought that there was significant improvement in chest fluoroscopy, particularly in the pulmonary markings, but the fluoroscopy of the abdomen was unsatisfactory, as the image was lost in the noise levels encountered. The essential link which made this system possible was the development of the 5820 image orthicon

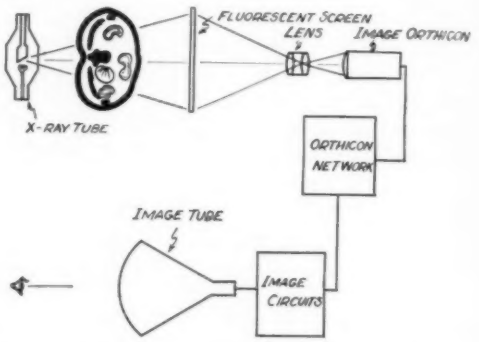

Fig. 2. Schematic diagram of television system for amplification of the fluoroscopic image.

television tube with sensitivity and other characteristics notably improved over earlier tubes. Since that time, Morgan and co-workers have continued investigations in television amplification with appreciable improvements, and with the co-operation of Dr. Peter Goldmark our group at the University of Pennsylvania has energetically pursued research into the many physical factors involved. A schematic diagram of the components of a television system is shown in Figure 2. It is more cumbersome than the direct tube but offers opportunities for control in pulsing, storage, contrast, and field of coverage which make its further investigation essential. Within the past four weeks, by use of elaborate (and costly) experimental circuits, we have at last obtained images which I consider to be superior to those presently available by any other means.

Our expectations are sharpened by new advances in the physics of optics which now make available lenses of excellent quality with aperture ratings of f1:0.75, a factor of major value in this type of system. Yet further improvements in many components of television systems are possible.

The basic physical problem in all attempts to amplify fluorescent images may be simplified by the consideration of information versus noise as diagrammed in Figure 3. The clarity of the original information which may be present in a sharp alteration of radiographic density may

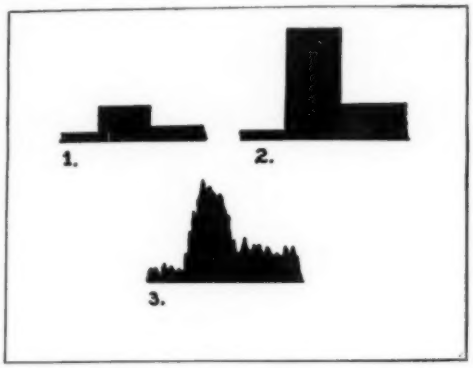

Fig. 3. Factors of noise influencing the amplification of information in electronic amplification of the fluorescent image. 1. Original information. 2. Desired amplification. 3. Result obtained influenced by noise.

not be maintained in the desired amplification because of the extraneous influences of additions, subtractions, and distortions which mask it as noise. In fluoroscopy, the low intensity of radiation introduces inescapable noise in the form of the random fluctuation of photons (10). This can be counteracted in television systems by the use of storage principles.

In electronic circuits, further noise elements are added in each stage of transmission and amplification. In photofluorography and cinefluorography, the physical problems are variants of these roentgen beam and optical considerations, with the addition of special ones with respect to photographic films.

There is a further field for the application of physics in the interpretation of radiographic images which, although related to the foregoing, seems to deserve special mention. The visibility of an object is influenced by the unsharpness of its borders as well as by its relative brightness as determined by transmission

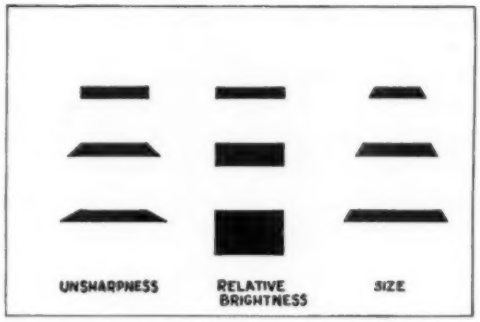

Fig. 4. Physical factors associated with the visibility of objects. Profile of test objects.

characteristics, film processing, and viewing conditions. Except in the case of minute objects, size does not appear to influence visibility. Various aspects of these factors have been studied by Newell (12), Morgan (13), and others (27). Their quantitative relationship has recently been

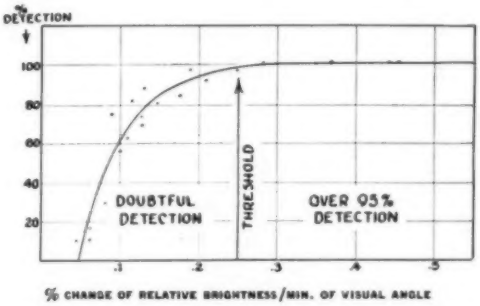

Fig. 5. Relationship of physical factors to the visibility of shadows expressed as percentage change of relative brightness per minute of visual angle.

investigated by Tuddenham and Hale, of our Department, in a series of enlightening experiments. Using test objects with profiles as represented in Figure 4, these workers derived a curve of visibility of objects as presented in Figure 5. Since only the factors of unsharpness and relative brightness need be considered, these can be expressed together as the per cent change of relative brightness (sometimes called contrast) per minute of visual angle. This curve is remarkable in showing a relatively sharp threshold of certain visibility (95 per cent). On the basis of such experimental observations, it is hoped that a more definitive approach may be made to the

causes of the discrepancies in clinical interpretation by distinguishing psychological factors from physical ones. Of greater import is the prospect, derived through mathematical considerations from these data and confirmed by preliminary field experiments, that there may be a real

PHYSICS IN RADIATION THERAPY

During the past twenty years the physics of radiation therapy has been responsible for major changes in the direction and methods of its clinical manipulation. We must not lose awareness of the considerable accomplishments of the

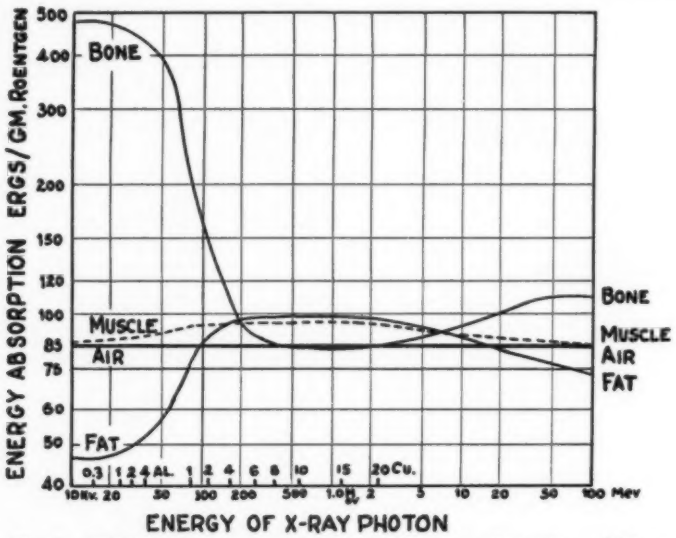

Fig. 6. Relationship of energy of radiation to energy absorption. (After Johns.)

clinical reward in the use of radiations generated in the million-volt range for human radiography. When the classic attitudes of desirable film contrast are replaced by the considerations introduced in these experiments, there is indication that the energy absorption characteristics of the million-volt range, as shown in Figure 6, may be of advantage in bringing beyond the threshold of visibility lesions otherwise hidden in the mediastinum and at the lung margins. The films so obtained do not satisfy conventional criteria for brilliance and beauty, but they do render visible objects otherwise hidden in the chest and introduce interesting possibilities for the use of air and saline as contrast media.

Suffice it to say that the status of roentgen diagnosis is not yet rigidly patterned and that much of its future may be presaged in the physics from which it will gain impetus and inspiration.

early radiotherapists who achieved so much by empirical methods alone. Furthermore, physics will never furnish the complete answer to the enigma of malignant disease and its treatment, but it is essential in defining the patterns of dosage distribution in quantity and volume so that radiobiological phenomena may be observed and applied free of these complicating factors.

A few years ago, radiation therapy was largely limited to x-ray beams of low and moderate energy levels and to the use of radium and radon. It should be emphasized that the great bulk of radiotherapy is still properly accomplished by these means and that familiar and conventional methods should not be discarded for the sake of novelty in relatively untried and inadequately explored measures. There are now instances of specific situations in which new methods seem applicable to

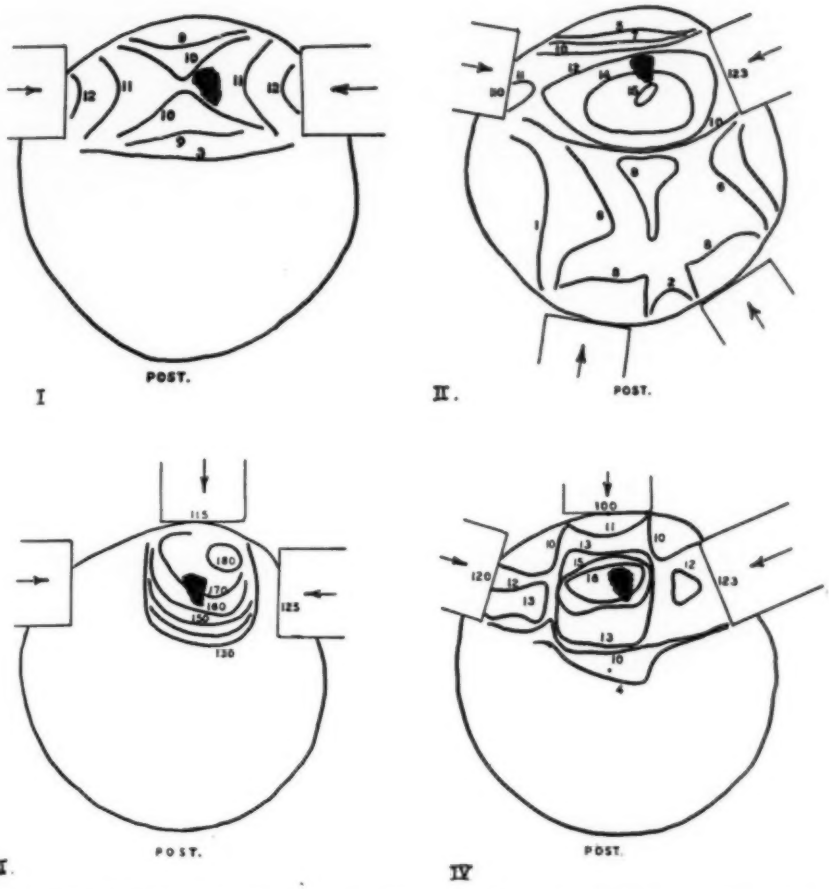

Fig. 7. Experimental calculations of summation isodose curves in treatment of cancer of the larynx. Optimum choice is Plan IV.

treatment not previously possible and others in which side reactions or other complications may be reduced. Nevertheless, the clinical verification of their worth will be long in the making. With the considerable list of modalities now available, we need a knowledge of physics in choosing the best instrument and the guidance of physics in applying it to the maximum extent.

Modalities of Radiation Therapy

A. External Beam
   1. Low-, intermediate-, and high-voltage x-rays
   2. Supervoltage x-rays
   3. Gamma beam (cobalt, cesium, iridium)
   4. Electron beam
   5. Neutron beam—secondary activation
   6. Proton beam
   7. Cross-fire; rotation methods

B. Interstitial Sources
   1. Radium needles; radon
   2. Other isotopes: Co^{60}; Au^{198}

C. Interstitial Colloidal Isotopes
   Au^{198}; chromic phosphate (P^{32})

D. Intracavitary Sources
   1. X-rays
   2. Point and linear sources (radium; radon; Co^{60})
   3. Liquid isotopes (Co^{60}; Br^{82})
   4. Colloidal isotopes (Au^{198}; P^{32})

E. Metabolically Localized Isotopes
   1. P^{32}: oral and intravenous
   2. I^{131}: oral and intravenous
   3. Colloidal Au^{198} and P^{32}: intravenous
   4. Other radioactive isotopes: Na^{24}

In the use of external beam radiation,

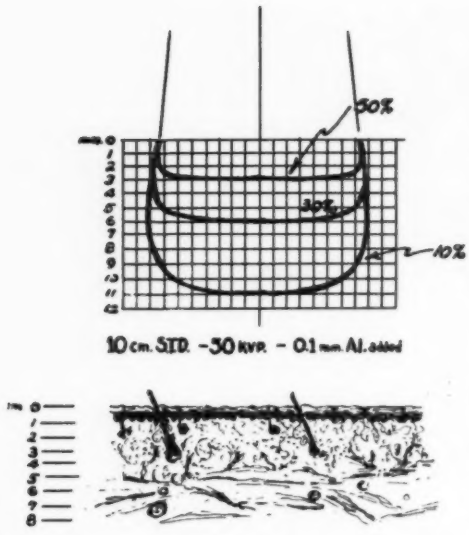

Fig. 8. Isodose contours (calculated) for beryllium window (1.0 mm. thickness) irradiation.

the physical factors which are practically related to clinical employment can be outlined as follows:

Physical Factors in Beam Therapy

A. Calibration
   1. Quantitative: dose rate
   2. Qualitative: half-value layer—$D^1/_2$
   3. Uniformity of fields
   4. Influence of errors
B. Air, Skin, and Tissue Doses; Fall-off Ratio
C. Isodose Contours—Summation Isodoses—3-Dimensional Isodoses
D. Integral Dose
E. Health and Safety
   Area, personnel, patients
F. Output Monitoring
G. Coefficients of Absorption

The accurate calibration of beam therapy equipment in terms of roentgen output and half-value layer is now well established as essential to the operation of this apparatus. The uniformity of field distribution is not always subjected to the attention which it deserves, however, and an appreciation of the magnitude of various potential errors is well worth careful consideration (3). Special problems of calibration still exist, particularly in the very low and very high energy ranges, where the instrumentation is most difficult.

Even in the simplest therapeutic uses, the advantages of expression of dosage in terms of air, skin, and tissue dose are obvious, though not always derived numerically or by estimation. In the low-voltage range, the rapidity of attenuation of the distal portion of the beam can be usefully expressed in terms of the fall-off ratio (14). These factors, however, do not represent the full statement of quantity and volume distribution, and the merits of isodose contours and summation isodose computations are magnified when radiation is applied for the definitive management of malignant disease with the prospect of cure. The technics for these studies and their elaboration in three dimensions are in large part attributable to the British group of physicists and therapists (15, 16, 17). An example of this approach is illustrated in Figure 7, in which a series of studies of patterns of radiation beam alignments for treatment of cancer of the larynx shows the best distribution to be in the fourth pattern of those considered, in terms of uniform highest dose delivery to the desired area and avoidance of excessive dosage to other normal tissues, including the spinal cord.

It is not often that one has the opportunity of observing directly the effect of isodose contours in terms of biological reaction. An instance of this is illustrated in the use of low-energy radiation from a beryllium window tube which, with the physical factors and filtration employed, has calculated isodose contours as shown in Figure 8. With such distribution and the use of 500 r, in air, to multiple round portals, administered in a single sitting, the result in four weeks is shown in the sharply demarcated and superficial regression of the large hemangioma of the face shown in Figure 9A. The result at seven months, following moderate additional therapy, is illustrated in Figure 9B. This is a type of therapy in which the physical factors should be thoroughly known, for the depth penetration must be sharply limited and the superficial radiation precisely known and controlled.

Fig. 9. Beryllium window radiation of hemangioma of face. A. Four weeks after initial treatment, showing uniform and sharply limited regression in round portal areas. B. Result in seven months; radiation effect limited to superficial tissues.

In recognizing the relationship of the volume of tissue included in known ranges of dosage with respect to biological effect, Mayneord has proposed the interesting and useful expression of integral dose. The unit of integral dose is the gram-roentgen. Simplified formulae are available for computing the integral dose in practical applications (18). In the analysis of good results and reduced complications in restricted area treatment, with respect to volume and dose, as in a recent report on optimum dosage by Paterson (19), this is likely to be pertinent, although its larger field of usefulness has seemed to lie in large volume beam therapy, radioactive isotope therapy, and health and safety considerations.

The validity of dosage measurement also depends on the energy-absorption characteristics of various tissues in relation to the energy of the radiation employed (20, 21), as shown in Figure 6. This is commonly neglected in dosage determination. There are significant differences in supervoltage ranges and also in use of the low-energy radiation obtained with beryllium window tubes.

Research in radiobiology is being pursued with increasing interest, spurred by new pressures from the radiation problems of atomic warfare as well as the more familiar ones of cancer. Studies in radiobiology are full of pitfalls for the unwary, but the means are at hand for adequate control of time, dose quantity and distribution, and volume considerations. It is well to remind ourselves that the interpretations derived from the exposures of myriads of experimental animals, as well as human material, may be invalid if a high order of precision is not applied to the physical factors of the radiation used.

An illustration of this was brought home to me in a series of experiments performed to explore the relationship of very short time pulses of radiation (5–10 microseconds duration, 1:80 duty cycle) to radiobiological effects in mice. An initial series seemed to show marked, and statistically significant, differences between the pulsed exposure and control groups. Small potential errors in instrumentation were then uncovered and the experiment was repeated with tripled attention to possible physical errors. These later experiments showed no significant difference between pulsed and control groups. Such radiobiological considerations have direct

Fig. 10. Radon seed calibrations. Summary of accurate assay of a series of radon seeds to show spread of radon content, certified to be 1.0 mc.

inferences in clinical therapeutic and diagnostic apparatus and its use.

With interstitial or intracavitary radium and radon therapy, the basic physical considerations are essentially similar to those in beam therapy, but the technics for obtaining comparable precision in dosage measurement are, in my opinion, considerably more complex. Primary attention is directed to the accuracy of source strength. In Figure 10, the calibration of a recent series of shipments of radon seeds is plotted with respect to the strength of individual seeds, all of which were certified to a corrected content of 1.0 millicuries of radon by a commercial source of good reputation. Regardless of the cause to which these discrepancies may be attributed, such a spread of variation precludes any serious attempt at accurate dosage planning and leaves the user with the obligation of investigating the accuracy of his own sources. Radium needles also deserve critical examination to avoid errors which may be introduced by leakage or packing of the element.

Dosage calculations are based on the excellent curves of Paterson and Parker (22), the linear dose tables of Quimby (23), or the isodose curves of Wolf (24). The ultimate in three-dimensional plotting of radium needle dosage pattern can be procured by a major expenditure of effort. Such a plan in the treatment of carcinoma of the cervix by radium needles is shown in the multiplane reconstruction of Figure 11, for which I am indebted to Drs. Nichols and Carpender of the University of Chicago

TABLE I: FIVE-YEAR RESULTS IN TREATMENT OF CARCINOMA OF THE CERVIX, 1940–45

League of Nations Classification (1937)	Patients Treated by Irradiation	Relative Five-Year Cure Rate
Stages I–IV	183 (100%)	44.8
Stage I	46 (25.1)	74.0
Stage II	68 (37.2)	45.6
Stage III	55 (30.1)	27.3
Stage IV	14 (7.7)	14.3

(25). The physical representation of inadequate dose coverage in certain areas, with excessive radiation to others, was sufficiently apparent to warrant abandonment of the treatment plan used in this example.

As the results of radium therapy are more critically reviewed with respect to the incidence of complications as well as to relative cure, dosage pattern studies assume new practical importance. In Table I are presented the relative cure rates for cervical carcinoma treated during a five-year period with a plan of external and intravaginal roentgen irradiation, followed by radium in the cervical canal and fornices. These results are a notable improvement over previous ones in our insti-

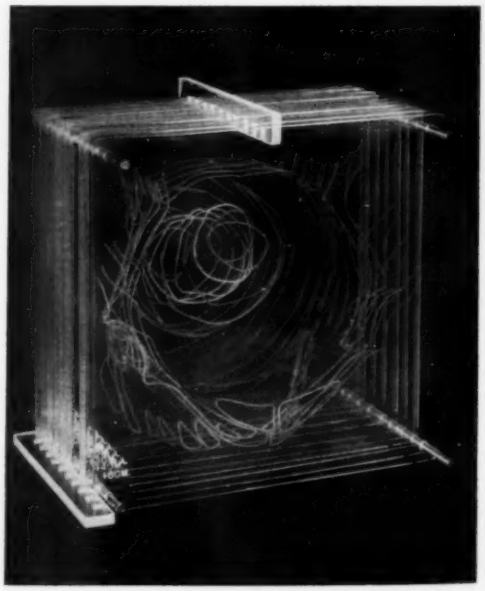

Fig. 11. Three-dimensional study of isodose contours in radium needle treatment of carcinoma of the cervix (by Nichols and Carpender).

Fig. 12. Orthoradiographic projections of radium distribution in treatment of carcinoma of the cervix. Satisfactory distribution on three-dimensional calculations. A. Anteroposterior view with radiopaque material in the bladder and ureters catherized. B. Anteroposterior view with radiopaque material in the rectum. C. Lateral view.

tution and would justify considerable gratification, but they have been accompanied by a rise in major and minor post-irradiation complications, represented in over-all forms, in the group suitable for analysis, in Table II. This table illustrates an appreciably higher incidence in the higher radium dosage group, although the 3,000–4,000 r x-irradiation was unchanged. Complete data are not available for re-examination of these cases with regard to the complete pattern of radium dosage expressed in roentgens, but this analysis has given meaning to our present studies which are applied to radium treatment of cervical carcinoma as illustrated in Figures 12 and 13. The illustrations are from a program carried on jointly with the Department of Gynecology. In these films, made on orthographic apparatus (26), three-dimensional reconstruction is possible. Opaque media in the bladder,

Fig. 13. Orthoradiographic film of radium in poor position for the treatment of carcinoma of the cervix. The three-dimensional calculations show the dosage in the left ureter to be three times that in the right ureter.

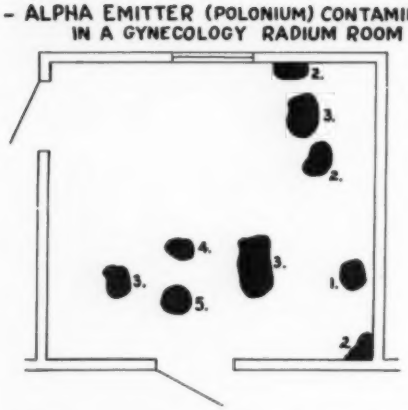

Fig. 14. Alpha contamination in a radium room. Areas of alpha contamination graded from maximum (5) to minimum (1) on arbitrary scale.

rectum, and ureters permit complete calculation of dosage at all points of these organs, derived from the radium which is in place when the exposures are made.

In the first case (Fig. 12) placement is satisfactory, but in the second it is so asymmetrical that the radium was removed immediately and another technic of treatment substituted. In intermediate cases, minor adjustments in placement, packing, or total dosage can be logically deduced from the computed radiation delivered to all critical points. This approach seems to be more rational than dose calculations to the theoretical points A and B alone; it is logically satisfying, and the extra effort involved will be justified if the clinical end-results can be better evaluated. We can also hope that by this means the results will themselves be improved.

In every operation in roentgen diagnosis and radiation therapy, health and safety deserve the attention of applied physics. Hazards may be uncovered in the most unexpected places. In Figure 14, alpha emitter (polonium) contamination found in a gynecology radium preparation room is plotted with arbitrary units of intensity. A few old and leaking radium cells were responsible for this, as well as heavy contamination of the instruments and storage block used.

PHYSICS IN RADIOACTIVE ISOTOPE THERAPY AND DIAGNOSIS

To gain a full realization of the therapeutic and diagnostic potential of radioactive isotopes, the foregoing features form a rational background. The variety of characteristics of isotopes requires inspection of special problems in dose preparation, dose evaluation, and health and safety. Initially, the favorable and unfavorable elements in the nature of each radioactive isotope and its emissions can be considered within the scope of the following outline:

TABLE II: POST-IRRADIATION COMPLICATIONS IN CARCINOMA OF THE UTERINE CERVIX, 1940-45: RELATIONSHIP OF RADIUM DOSAGE TO INCIDENCE OF COMPLICATIONS

Number of patients receiving 3,000 to 4,000 r to each parametrium and living more than two years after treatment 65

Radium Dosage (mg. hr.)	Number of Patients	Number of Post-irradiation Complications	Percentage of Post-irradiation Complications
Less than 5,000	19	6	31.6
5,000 or more	46	30	65.3

Characteristics of Isotopes Used

A. Chemical Form
B. Physical Form
C. Half-Life
D. Emissions
   1. Type: alpha, beta, gamma, etc.
   2. Energy levels
      (*a*) Spectrum
      (*b*) Maximum and average ranges in tissues
E. Decay Products

A representative selection of pertinent data for the isotopes most useful in clinical applications is shown in Table III.

Certain radioactive isotopes can be applied as substitutes for radium and radon which are, of course, also radioactive isotopes. With the exception of corrections for the energy levels of their emissions and for novel patterns of distribution, they could have been considered with radium and radon. Conversely, much of the apparatus for assay or health and safety use developed for radioactive isotopes is eminently useful in a radium and radon

TABLE III: NOTES ON THE PHYSICAL CHARACTERISTICS OF SIX RADIOISOTOPES

Isotope and Half-Life	Beta Emissions							Gamma Emissions (mev)	μc/kg for 0.05 rep in 24 hr.
	Energy (Mev)		Range in Water (mm.)		Av. No. Ions	Specific Ionization*	rep per μcd per gm.		
	Max.	Av.	Max.	Av.					
$_{6}C^{14}$, 5,600 yr.	0.15	0.05	0.30	0.06	1500	26	68×10^{5}	...	17
$_{11}Na^{24}$, 14.8 hr.	1.4	0.54	6.3	1.7	17000	10	29	1.4, 2.8	2.6
$_{15}P^{32}$, 14.3 days	1.69	0.69	7.8	2.4	21000	9	8.66×10^{2}	...	1.2
$_{27}Co^{60}$, 8.3 yr.	0.3	0.1	0.77	0.17	3100	18	1.71×10^{4}	1.1, 1.3	8.2
$_{53}I^{131}$, 8.0 days	0.6 (85%)	0.2	2.0	0.45	6200	14	1.41×10^{2}	0.37 (79%)	4.2
$_{79}Au^{198}$, 2.7 days	0.98	0.32	4.0	0.84	9900	12	76	0.41	2.9

* Specific ionization is expressed as average number of ions per micron of average effective path length.

laboratory. We can be grateful that the needs of radioactive isotope procedures promoted the development and manufacture of such equipment. However, the increase in physical complexity which concerns us most is in the use of liquid radioactive materials with intracavitary, interstitial, and metabolically localized distribution. In quantitative determination of such distributions, out of the bounds of control applicable to the radiations previously dealt with, the tools of precision are variations of Geiger-Müller apparatus, ionization chambers, scintillation instruments, and special photographic methods. Certain types are adapted to assays of original preparations and samples of tissue and body fluids as well as to health and safety surveys. Each form of instrument must be chosen and used in the light of the factors enumerated below:

Instrumentation of Radioactive Isotopes

I. Geiger-Müller Apparatus
  A. Scalers: binary and decimal
  B. Rate meters
  C. Tubes
    1. Construction—filling gases
    2. Collimation and shield design
  D. Evaluation of measurements
    1. Coincidence losses; counting statistics
    2. Geometric considerations
    3. Absorption and scattering
    4. Tube and circuit instability
II. Ionization Chambers
  A. Condenser chambers—survey meters
  B. Energy dependence
  C. Saturation—size
  D. Associated electrical circuits
  E. Sensitivity—portability
III. Scintillation Instruments
  A. Crystal characteristics
    1. Energy response
    2. Pulse height distribution
    3. Pulse duration
  B. Light transmission
  C. Photomultiplier tubes
  D. Coincidence circuits
  E. Pulse height discrimination
  F. Scanning apparatus
  G. Collimation and shield design
IV. Photographic Methods—Autoradiography
  A. Resolution
  B. Emulsion characteristics—energy response; development
  C. Photodensitometry
  D. Histological processing—leaching
  E. Grids and intensifying screens

In therapeutic applications, the full employment of this array of physical devices makes the co-operation of an informed physicist advisable, if not essential. The physician needs education in the pertinent special problems, in addition to a comprehensive grasp of conventional radiation therapy, to take full advantage of this coalition of efforts.

An example of the results of this teamwork is seen in the use of scintillation counters for the external mapping of gamma-emitting isotopes whose internal distribution depends on metabolic phenomena. The quantitative accuracy of the determinations by no means compares with beam or particulate interstitial source studies, nor is the resolution of the apparatus sufficient to give information concerning the inequalities in localization which determine the dosage within the

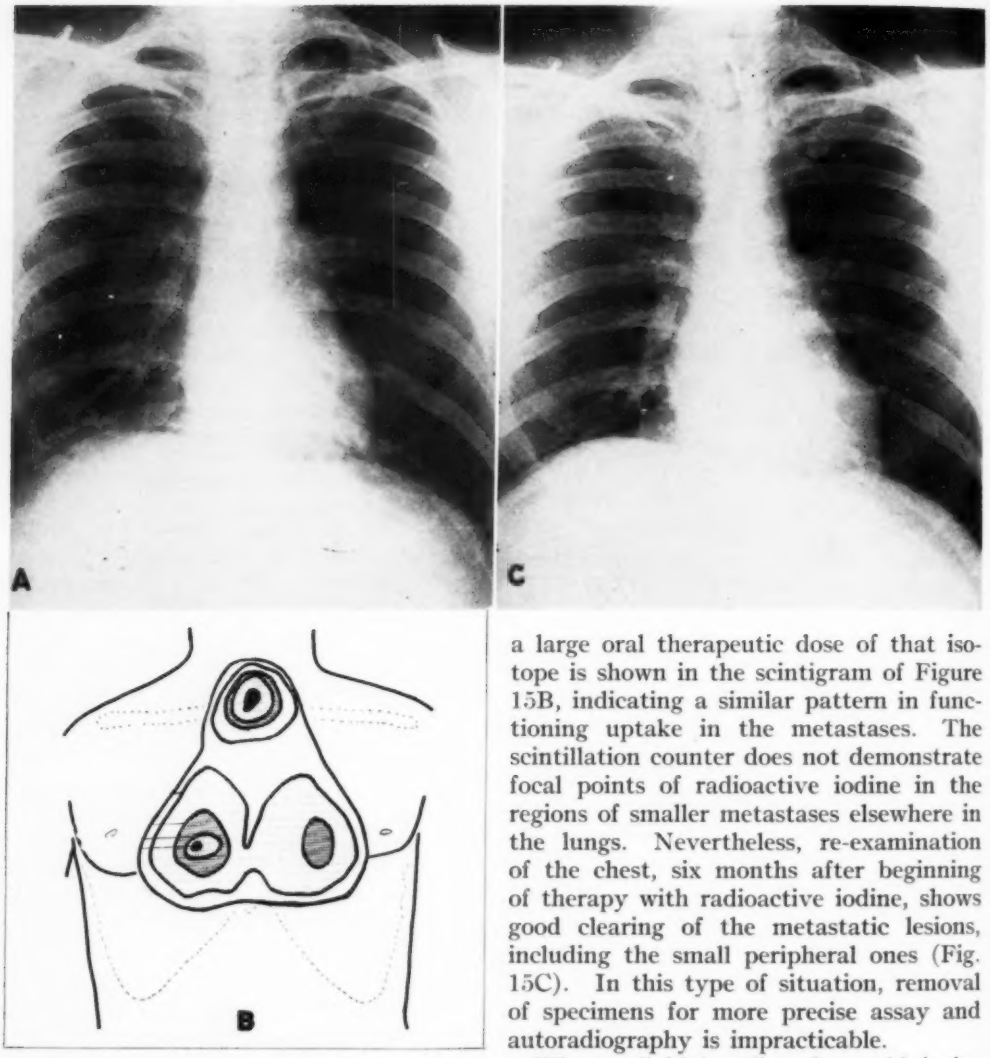

Fig. 15. Scintillation counter survey of patient with pulmonary metastases from thyroid carcinoma following administration of radioactive iodine (75 mc.). A. Postero-anterior roentgenogram showing distribution of pulmonary metastases, particularly at both bases. Unfortunately these are not as clear in the reproduction as in the original film. B. Scintigram showing good localization of radioactive iodine in regions of prominent metastases. C. Postero-anterior roentgenogram six months after beginning of radioactive iodine treatment, showing marked clearing of metastases.

range of the beta emissions. In Figure 15A, pulmonary metastases from carcinoma of the thyroid are most numerous in the lower lung fields close to the heart. The fixation of radioactive iodine from a large oral therapeutic dose of that isotope is shown in the scintigram of Figure 15B, indicating a similar pattern in functioning uptake in the metastases. The scintillation counter does not demonstrate focal points of radioactive iodine in the regions of smaller metastases elsewhere in the lungs. Nevertheless, re-examination of the chest, six months after beginning of therapy with radioactive iodine, shows good clearing of the metastatic lesions, including the small peripheral ones (Fig. 15C). In this type of situation, removal of specimens for more precise assay and autoradiography is impracticable.

When colloidal radioactive gold is injected intraperitoneally for the control of recurrent ascites due to metastatic cancer, the scintillation counter can furnish information as illustrated in Figure 16. In this instance, the verification of good dispersion, without loculation, enhances the outlook for a satisfactory result, which was confirmed by the clinical course of events.

Sometimes the unexpected will be revealed in scintillation counter studies, as in an instance in which we found an appreciable amount of the colloidal radioactive gold in the pelvic portion of the

peritoneal cavity after injection into the pleural cavity.

The latitude of dosage which may be acceptable for desperate situations such as these may not be so lightly regarded if more precise alternatives exist in other means of treatment. Perhaps the seeming ease of accomplishment of satisfactory results in the use of P^{32} for polycythemia vera and of I^{131} for hyperthyroidism has resulted in a tendency to neglect the potentialities for tissue-level dosage difficulties with each of these isotopes. It is well to keep in mind how little information can be obtained after the isotopes are administered in each case. This will dictate conservative evaluation of their indications and close attention to their physical calibration and assay.

The diagnostic applications of radioactive isotopes continue to expand and have reached the status of requisite clinical procedures in the analysis of thyroid function, study of blood dynamics and volumes, and for the localization and metabolic studies of certain tumors. Superior results are more likely of attainment when several contributing members enter upon these projects, each with his own appropriate professional contribution. To this end, the radiologist who has familiarized himself with these aspects of applied physics will be welcomed as an essential contributor. Economy and efficiency of instrumentation, competence in radiological safety and health, and understanding of the meaning of the results of measurements based on instruments can make radiologists and their departments the logical center for such activities.

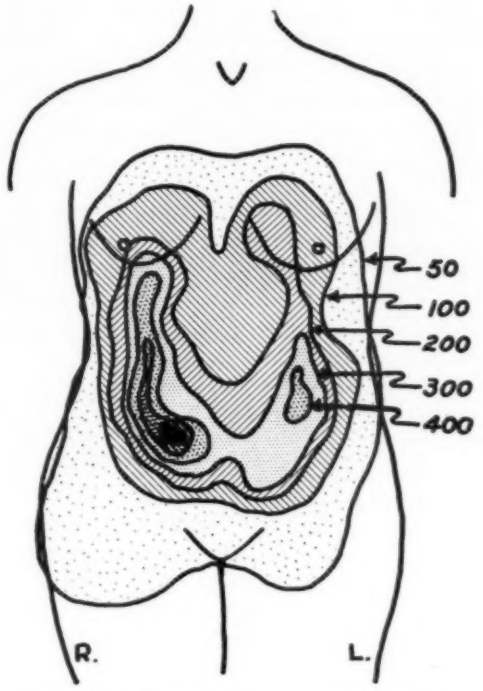

Fig. 16. Scintillation counter survey of patient following intraperitoneal injection of radioactive colloidal gold (125 mc.). The intensity patterns follow anatomical contours with remarkable detail. Distribution considered satisfactory. (After Gorson.)

INTEGRATION OF PHYSICISTS AND RADIOLOGISTS

It is a purposeful coincidence that is responsible for my choice of subject on this occasion, for this meeting of the Radiological Society of North America marks the inception of the program with emphasis on the allied sciences in relation to radiology. It is to be hoped that a comprehensive interest in radiological physics and radiobiology can be encouraged. There are satisfactions in knowledge as its own reward, but mutual comprehension brings fresh stimulation to basic scientist and clinician alike.

In Philadelphia, we have had a long and happy experience with educational programs in the Graduate School of Medicine wherein the radiological physicists, as well as clinical radiologists, from every institution have pooled their efforts in the teaching of trainees in radiology. As the activities in radiological physics have increased, a younger group of physicists has been trained by this nucleus and they have enlarged their own backgrounds to include basic biological and preclinical medical subjects to bridge the gap in mutual understanding with the radiologists. These men are scientists of the first order, worthy of academic rank in the institutions with which they are associated, and they ensure

continued gains in the interpretation of physics into clinical adaptations. We have come to hold in high esteem their daily cooperation in dosage planning, instrumentation, and radiation protection, as well as in our research activities.

In the recent past, we have instituted a weekly conference in which radiologists and physicists from the entire Philadelphia area have participated. For clinical roentgen diagnosis there are a number of excellent conferences in the city, but the agenda for this weekly meeting are unique in dealing with the full scope of radiation therapy, radioactive isotopes, radiological physics, and radiobiology. In addition, there are included equipment, protection, and basic research in diagnostic radiology and the radiological problems of atomic warfare and defense. The vital need for this concentration of interests has been evident in the vigor with which it has been continued, to full-house participation. We have wished the physicists to feel as free in filling the blackboards with formulae as the physicians are in discussing the side reactions of androgenic hormones. Either by gradual assimilation or purposeful simplification, a meeting of minds in understanding of principles has been achieved in every topic discussed so freely there. This conference has offered extended benefits for radiologists from smaller institutions and private practice and furnishes a pattern whereby this larger segment of our co-workers may practice and keep abreast of physics rather than let it lapse into the category of things once learned but seldom used. A certain minimum of formal background is obligatory, but continuation of growth depends on an attitude of mind which must be cultivated.

There is close relationship in the physics of radiological diagnosis and radiation therapy. The physics of radioisotopes lies between these two as well as beyond them. Perhaps there is much to be said for the exercise of individual freedom of choice by the radiologist in defining his sphere of activities, rather than in attempting to delimit his scope to the distinct molds of roentgen diagnosis or radiation therapy.

This is the day of atomic physics, in which the bright high school boy may be surprisingly conversant with the properties of radioactive materials. A good measure of comprehension is within the reach of all of us with a small outlay of time and effort in reading and listening.

We must not be ashamed or suspicious of fields of knowledge in which our completeness of coverage is, of necessity, fragmentary. No one should be more aware of this than the radiologist, whose daily clinical efforts are so diversely directed. In defining the place of physics in clinical radiology it is desirable to bring to light the body of information acquired in early training and to continue to amplify it with regular use. Physics will then occupy its rightful position—in the stream of daily thought and integrated into the practice of the clinical radiologist.

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SUMARIO

El Puesto de la Física en la Radiología

Ninguna otra rama de la medicina debe tanto como la radiología a los colaboradores de otros campos científicos afines. Desde su misma iniciación, un punto fundamental de esa relación ha residido en su asociación con la física. Primero, la física facilita el hilo de comprensión básica que atraviesa todo el terreno de la radiología y permite absorberla más fácilmente como todo integrado. Segundo, suministra el método de aplicación a problemas específicos del roentgenodiagnóstico y la radioterapia.

Con mucho, el mayor volumen de esfuerzo dedicado a las aplicaciones prácticas de la física se ha cifrado en el perfeccionamiento de aparatos y técnicas para el diagnóstico roentgenológico. Conciernen los mismos: (1) los focos de irradiación; (2) los receptores de la irradiación, incluso emulsiones fotográficas y receptores fluorescentes; (3) la física de la interpretación, comprendiendo en particular los factores de la visibilidad.

En la radioterapia, la física es indispensable para definir los patrones de la distribución de la dosis en cantidad y volumen y en escoger los mejores de los varios métodos terapéuticos con que contamos hoy día. Los últimos abarcan la terapéutica de haz externo procedente de varios focos, la irradiación intersticial e intracavitaria y el uso de isotopos localizados metabólicamente. También intervienen problemas relacionados con la salud y la protección.

El campo de los radioisotopos presenta problemas propios de preparación de la dosis, valuación de la dosis, instrumentación (aparato de Geiger-Müller; cámaras de yonización, instrumentos de chipseo; autorradiografía) y la inocuidad y la salud radiológicas.

Cítase como ejemplo de la integración de la física y la radiología la colaboración de radiólogos y físicos en los planes de enseñanza de la Escuela de Perfeccionamiento Médico de la Universidad de Pensilvania.

Isodose Distributions for a 1,100-Curie Cobalt^{60} Unit[1]

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IN AUGUST 1951, 1,100 curies of cobalt^{60} were loaded into the treatment head of a therapy unit in the University Hospital, Saskatoon. This unit was manufactured in Saskatoon by the Acme Machine and Electric Company for the Saskatchewan Cancer Commission, and the cobalt was activated in the Canadian reactor at Chalk River. Details of the construction of the unit will be found elsewhere (1, 2). In this paper a selection of the isodose distributions which are in current use at the Saskatoon Clinic will be presented.

The cobalt unit gives a depth dose equivalent to that produced with an x-ray machine operating at a peak energy of 3 million volts, and an output of 33 r per minute at 80 cm. distance (2). Since the unit is much simpler to operate and much more economical to construct than the equivalent x-ray machine, it is likely that a number of cobalt^{60} units will be in operation shortly. It is hoped that the isodose distributions presented here will be of value to those using such units.

DESCRIPTION OF THE UNIT

Twenty-five disks of cobalt, each 1 inch in diameter and 0.5 mm. thick, piled on top of one another, form a radiation source 1.25 cm. thick. This source is placed on the circumference of a composite lead steel and heavy metal wheel mounted on bearings near the center of a steel-encased lead cylinder 20 inches in diameter and 22 inches high. The unit is shut "off" by turning this wheel through 180°. In the "on" position, the source is opposite a tapered opening in the lead container. In the "off" position the material composing the diameter of the wheel is between the source and the tapered opening. The position of the wheel can be controlled from outside the room and the unit can be turned "on" only when interlocking doors to the treatment room are closed.

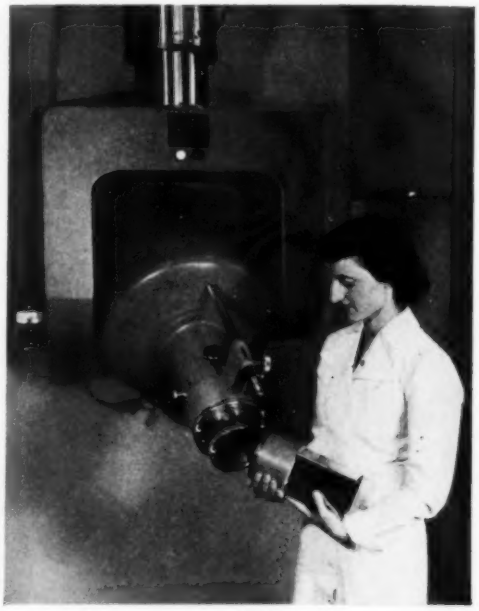


Fig. 1. Photograph of cobalt unit showing technician inserting treatment cone.

The unit, which weighs over a ton, is shown in Figure 1. It is suspended from a carriage which moves along an overhead track, and can be raised or lowered, moved in a horizontal direction, and rotated about a horizontal axis from the vertical position to 20° above the horizontal position. Details of these motor-driven motions will be found elsewhere (1).

COLLIMATION OF THE BEAM

The collimation of the gamma-ray beam is achieved through the use of steel-encased lead plugs which can be attached to the movable sleeve shown in Figure 1. A schematic diagram of one of these attachments is shown in Figure 2. The tapered openings at the center of these plugs yield

[1] From the Saskatoon Cancer Clinic, Saskatoon, Saskatchewan. Accepted for publication in April 1952.

fields of 4 × 4 to 15 × 15 cm., at a source-to-skin distance (S.S.D.) of 80 cm. For fields from 4 × 4 to 10 × 10 cm., the lead plugs are 8 cm. thick and the diaphragm-to-skin distance is 15 cm. For the larger fields the lead is 5 cm. thick and the diaphragm-to-skin distance is 20 cm. The

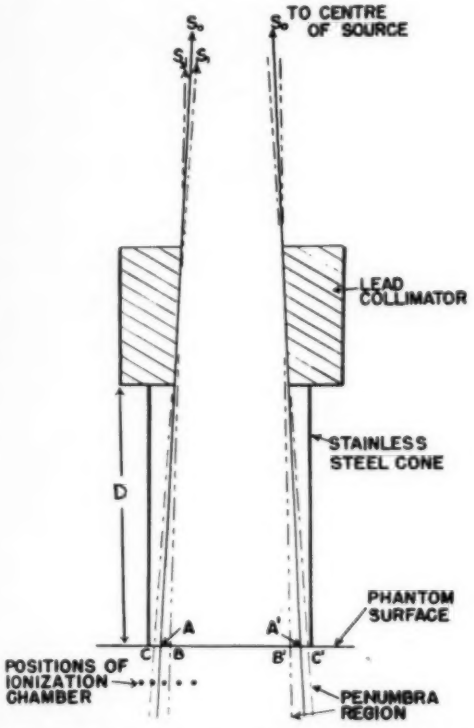


Fig. 2. Schematic diagram of a small treatment cone showing the penumbra region. This region has been exaggerated for ease in representation.

diaphragm-to-skin distance is defined by the use of open-ended stainless steel tubes which are permanently fastened to the lead plugs and enable accurate porting of patients. Such a collimating arrangement permits use of interchangeable treatment cones which weigh from 9 to 18 pounds.

One of the difficulties in the use of cobalt^{60} for a therapy unit is the relatively large penumbra region which surrounds each field. The path of radiation from the center of the source, S_0, through the collimating system is S_0A. Ray S_1C is the limiting ray from the right-hand edge of the

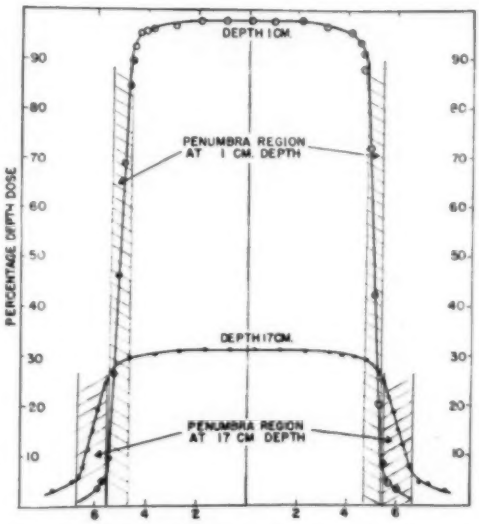


Fig. 3. Typical transits for the long axis of a 10 × 6-cm. field at depths of 1 and 17 cm.

source and S_1B the corresponding ray from the left-hand side of the source. If the source were very small, the penumbra region, CB, would be zero. In actual fact, the beam shades off slowly from the point B, which sees all of the source, to the point C, which sees only the edge of the source. The width of the penumbra, BC, can be made smaller by reducing the diaphragm-to-skin distance, D. This distance, however, cannot be reduced below about 15 cm. without introducing some difficulties in porting patients. Also, if the diaphragm is less than 15 cm. from the skin, it scatters electrons into the beam, which increases the skin dose and thus reduces the percentage depth dose (2).

For the small fields, with D equal to 15 cm., the distance BC is 6 to 7 mm. For the larger fields, where D is increased to 20 cm., BC becomes 8 to 9 mm. The penumbra region C to B increases in width as one proceeds below the phantom surface, and at points 15 cm. below the skin the distance BC will be approximately 12 mm. The experimental results discussed below indicate a penumbra region in agreement with this discussion.

The nominal size of the fields given in this paper are represented by AA^1 of

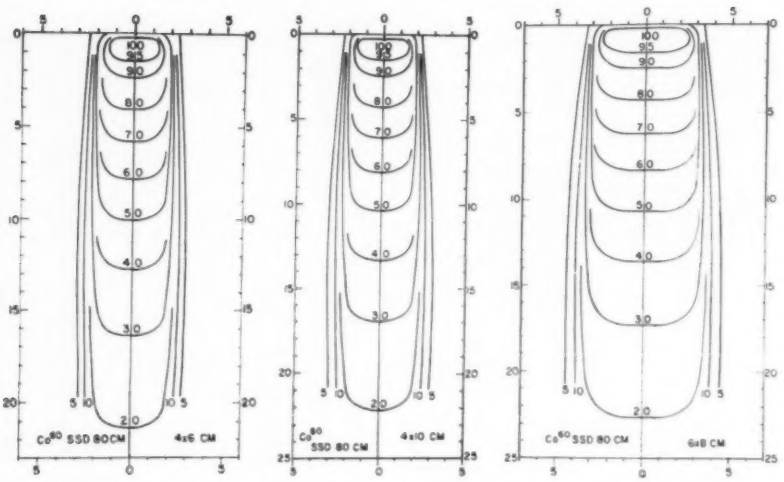


Fig. 4 (left). Isodose distribution for the short axis of a 4 × 6-cm. field, using cobalt at a source-to-skin distance of 80 cm.
Fig. 5 (center). Isodose distribution for the short axis of a 4 × 10-cm. field, using cobalt at a source-to-skin distance of 80 cm.
Fig. 6 (right). Isodose distribution for the short axis of a 6 × 8-cm. field, using cobalt at a source-to-skin distance of 80 cm.

Figure 2. The treatment cones, however, were made enough larger than AA^1 to include the outer edges of the penumbra, that is, slightly greater in size than CC' of Figure 2. All the treatment cones were designed to be used at a source-to-skin distance of 80 cm., where an output of 33 r/min. is obtained. This output varies slightly with the size of the field. The back-scatter amounts to 1 to 4 per cent, depending on the field size (4).

METHOD OF MEASUREMENT OF COBALT^{60} DISTRIBUTIONS

Measurements were made with a small cylindrical ionization chamber 3 mm. in diameter and 10 mm. long. This chamber, made of polystyrene and coated on the inside with carbon, was connected to a D.C. amplifier similar to one described elsewhere (3). The chamber was moved by remote control in a water phantom (5). Transits of the ionization chamber were made 1.0, 6.0, 11.0, and 17.0 cm. below the surface of the phantom. The axis of the cylindrical ion chamber was placed and moved parallel to one edge of the rectangular field being investigated. Typical positions of the chamber are shown in Figure 2, and typical transits for the long axis of a 10 × 6-cm. field in Figure 3 for depths of 1 and 17 cm. The position of the expected penumbra regions from the above considerations are represented by the shaded regions in Figure 3. The actual experimental points are shown as circles. In the penumbra region the dose falls rapidly as the distance from the central axis is increased. When the ionization chamber is all within or outside the penumbra region, the measurement is correct, but when half the chamber is inside the region and the other half outside, a slight error is introduced. The resultant curves, shown in Figure 3, have been drawn to correct for this error; they deviate slightly from the experimental points only in a small region 3 mm. wide (the size of the chamber) centered about the edges of the penumbra (6). If a larger ionization chamber were used, this averaging effect would make the transit curves more rounded.

The depth doses along the axis of the rectangular fields were obtained with the cylindrical chamber described above, as well as a flat type of chamber described elsewhere (7). The depth dose increases rapidly as one proceeds below the surface,

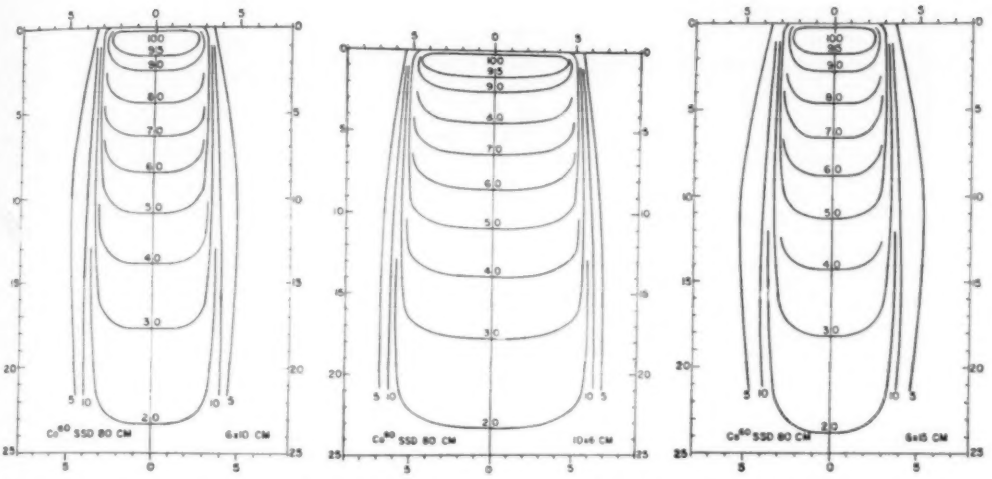


Fig. 7 (left). Isodose distribution for the short axis of a 6 × 10-cm. field, using cobalt at a source-to-skin distance of 80 cm.

Fig. 8 (center). Isodose distribution for the long axis of a 10 × 6-cm. field, using cobalt at a source-to-skin distance of 80 cm.

Fig. 9 (right). Isodose distribution for the short axis of a 6 × 15-cm. field, using cobalt at a source-to-skin distance of 80 cm.

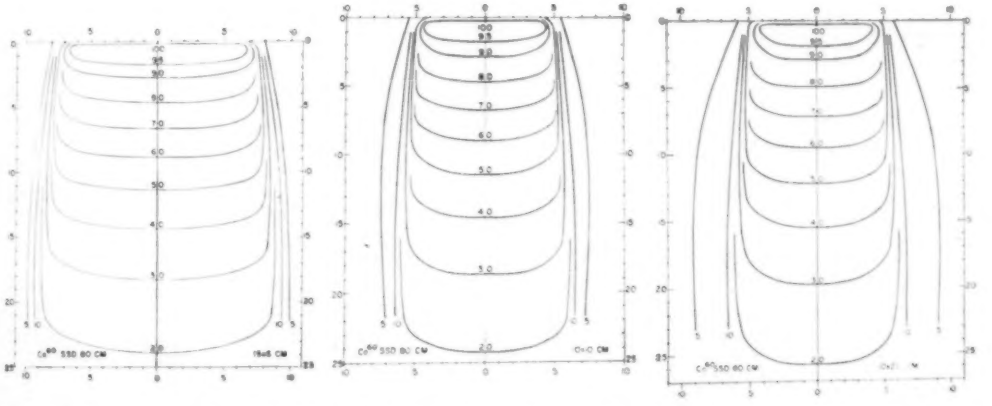


Fig. 10 (left). Isodose distribution for the long axis of a 15 × 6-cm. field, using cobalt at a source-to-skin distance of 80 cm.

Fig. 11 (center). Isodose distribution for a 10 × 10-cm. cobalt field at a source-to-skin distance of 80 cm.

Fig. 12 (right). Isodose distribution for the short axis of a 10 × 20-cm. field, using cobalt at a source-to-skin distance of 80 cm.

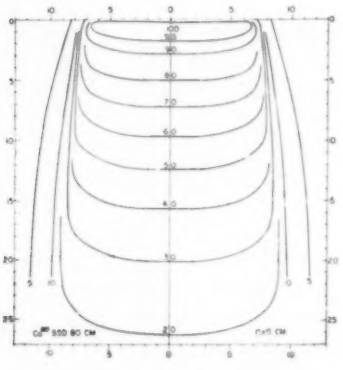
giving a flat maximum from 4 to 7 mm. below the surface. Tabulated values for a number of rectangular fields are given in Table I. The surface dose is hard to measure accurately and depends considerably on the diaphragm design. The values given for zero depth in Table I are approximate. These data for rectangular fields are in fair agreement with those obtained by Dixon *et al.* (4). On this basis, the complete isodose distributions can be constructed.

ISODOSE DISTRIBUTIONS

Isodose distributions for all the rectangular fields given in Table I have been prepared. Space does not permit the reproduction of all of these, but typical ones

TABLE I: DEPTH DOSE FOR Co^{60}
(Source-to-skin distance 80 cm.)

Depth	6 × 4	5 × 5	7 × 5	10 × 4	8 × 6	7 × 7	10 × 6	10 × 8	15 × 6	10 × 10	10 × 12	10 × 15	10 × 20	15 × 15
0 cm.	30	30	35	40	40	40	40	40	40	45	50	50	50	50
0.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1	97.2	97.3	97.5	97.5	97.6	97.6	97.8	97.9	97.9	98.0	98.0	98.0	98.0	98.0
3	85.5	85.6	86.2	86.2	87.1	87.2	87.4	87.9	88.0	88.2	88.5	88.7	88.8	89.0
5	74.2	74.4	75.4	75.5	76.7	76.8	76.9	77.9	78.0	78.2	78.7	79.0	79.4	79.9
7	63.9	64.1	65.3	65.4	66.7	66.9	67.0	68.2	68.3	68.5	69.4	69.8	70.2	70.8
9	55.5	54.8	56.0	56.1	57.2	57.3	57.9	59.2	59.3	59.7	60.7	61.2	61.8	62.5
11	46.4	46.7	47.9	48.0	49.0	49.1	49.8	51.3	51.4	51.9	52.9	53.2	53.9	54.8
13	39.6	39.9	41.0	41.1	42.1	42.2	42.9	44.2	44.3	45.0	46.0	46.4	47.2	48.1
15	33.7	34.0	35.0	35.1	36.1	36.2	36.9	38.2	38.3	39.0	40.0	40.4	41.3	42.2
17	28.7	29.0	30.0	30.1	31.0	31.1	31.7	33.0	33.1	33.9	34.8	35.1	36.2	37.0
19	24.5	24.8	25.7	25.8	26.7	26.8	27.1	28.5	28.6	29.4	30.2	30.5	31.7	32.4



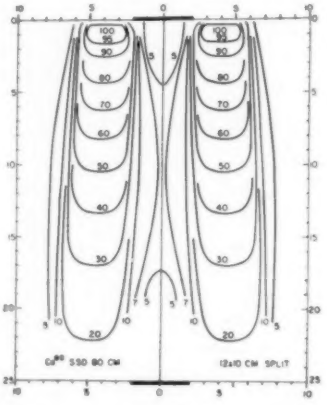


Fig. 13 (left). Isodose distribution for a 15 × 15-cm. cobalt field at a source-to-skin distance of 80 cm.
Fig. 14 (right). Isodose distribution for a 12 × 10-cm. "split" field, using cobalt at a source-to-skin distance of 80 cm. (Two 4 × 10 fields separated by a distance of 4 cm.)

are given in Figures 4 to 14 inclusive. It should be noted that the amount of radiation scattered outside the beam is relatively small. Figure 14 shows the distributions for a 10 × 12-cm. "split" field with a 4-cm. opaque region at its center. This field is useful in the treatment of the parametria following radium treatment for cancer of the cervix, and is virtually the same as two 10 × 4-cm. rectangular fields 4 cm. apart.

One of the advantages of the cobalt unit over x-ray therapy in the 200 to 400-kv. range is, of course, the greatly increased percentage depth dose obtained, which sometimes permits of considerable simplification of technics. This point, and an example of the combination of the isodose curves, can be illustrated in the supplementary treatment of the parametria following radium treatment of cervical cancer. Figure 15 shows alternative distributions obtained in such a case with the use (on the left side) of anterior and posterior opposing fields, with anterolateral and posterolateral additional ports, compared with (on the right) simple opposing anterior and posterior fields. All the fields measure 10 × 4 cm. and the anterior and posterior fields in each case are "split," as shown in Figure 14. One half only of each of the distributions is shown, since they are symmetrical about the mid-line. It appears that the four-field layout on the left is much superior to the simple two-field arrangement on the right. In the former, the dose at "point B" is about 220 per cent as compared with a maximum skin dose of 100 per cent, while in the latter, "point

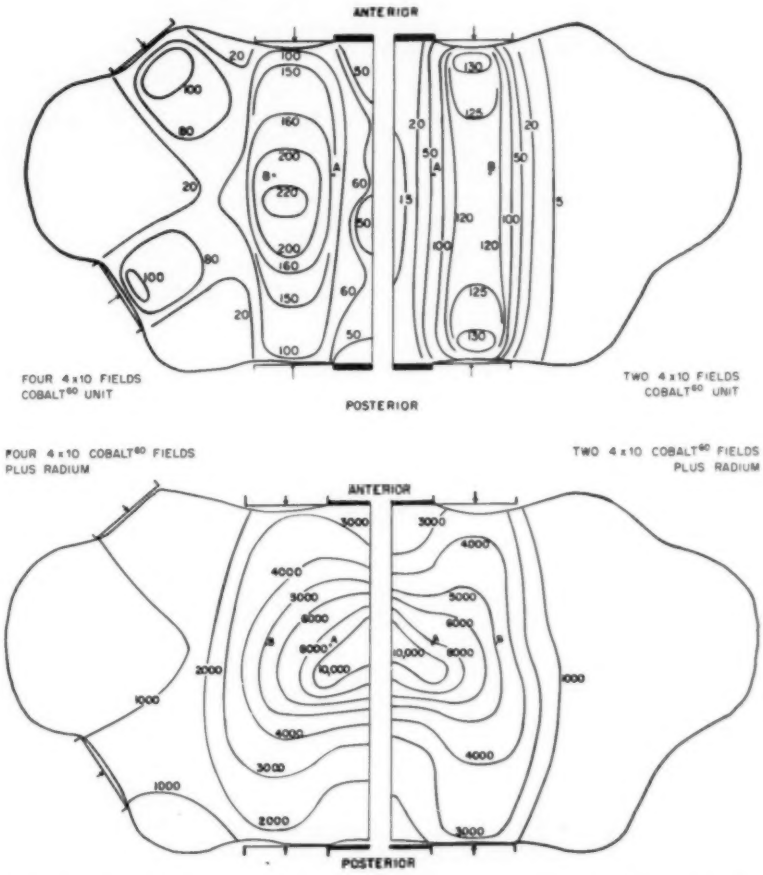

ANTERIOR
FOUR 4 x 10 FIELDS COBALT^{60} UNIT
TWO 4 x 10 FIELDS COBALT^{60} UNIT
POSTERIOR
FOUR 4 x 10 COBALT^{60} FIELDS PLUS RADIUM
TWO 4 x 10 COBALT^{60} FIELDS PLUS RADIUM
ANTERIOR
POSTERIOR

Fig. 15 (above). Comparative diagrams for two combinations of cobalt fields in the treatment of the parametria. Left-hand side of diagram shows the resultant distribution for a combination of four 4 × 10-cm. fields. The right-hand side of the diagram shows the resultant distribution for two opposing 4 × 10-cm. fields.

Fig. 16 (below). The resultant distribution for a combination of the cobalt fields shown in Fig. 15 and the distribution due to radium inserted in the uterine canal and the fornices. The cobalt fields were adjusted to give 3,000 r to "point B" and the radium adjusted to give 7,000 r to "point A." The radium insertion followed the Manchester technic.

B" receives 120 per cent for a skin dose of 130 per cent. When, however, these curves are combined with the isodose distribution obtained from the radium (Fig. 16), it will be seen that the combined distributions are quite similar. In each case the radium dosage was adjusted to 7,000 r to "point A," using the Manchester technic (8). Two "medium" ovoids, each containing 26.6 mg., and a spacer were used in the fornices, and an intra-uterine tandem contained one 10-mg. tube below and two 13.3-mg.-tubes above. The dose received at "point B" from the cobalt was made 3,000 r in both cases.

It is, of course, inaccurate to combine these isodose curves, since the space-time relationship of the radium dosage differs from that of the cobalt irradiation. By this means, however, we do obtain a broad picture of the comparative distribution of dosage in the pelvis at the end of the total treatment. It is doubtful whether the more complicated distribution on the left has much advantage over the simpler one shown on the right.

CONCLUSIONS

Although the source size in a cobalt^{60} unit must of necessity be considerably larger than the focal spot of a 2- to 3-mev x-ray machine, the isodose distributions of the cobalt^{60} unit compare favorably with those obtained with 2- to 3-mev x-rays. The penumbra effects with cobalt can be minimized by suitably designed treatment cones.

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SUMARIO

Distribuciones de Isodosis para un Aparato de Cobalto^{60} de 1,100 Curies

Preséntanse curvas de isodosis para la unidad terapéutica de cobalto^{60} de 1,100 curies de la Clínica de Cáncer de Saskatoon, Saskatchewán, Canadá.

Aunque el tamaño del foco en un aparato de cobalto^{60} tiene forzosamente que ser considerablemente mayor que el foco de un aparato de rayos X de 2 a 3 mev, las distribuciones de las isodosis de la unidad de cobalto^{60} compáranse favorablemente con las obtenidas con los rayos de 2 a 3 mev. Cabe reducir al mínimo los efectos de penumbra del cobalto con conos diseñados adecuadamente para tratamiento.

A New Tissue-Like Material for Use as Bolus[1]

DUNCAN D. LINDSAY, M. A.[2] and BABETTE E. STERN, B.Sc.[3]

CHARTS AND tables for the determination of x-ray dosage are based on measurements made in phantoms of regular shapes. In clinical practice the body surface on which the beam impinges is often irregular. In order to plan treatment so that doses can be correctly determined, it is necessary to provide a regular surface by filling in with bags of bolus material. This is particularly important with tangential or acutely slanted beams such as are used in irradiation of the chest wall following breast operations, and in regions such as the axilla or about the jaw. The need for use of such material is generally accepted, although the degree of its importance is not always appreciated.

Various materials have been used for this purpose, most of which have been open to some objection. Early bolus materials such as rice, bicarbonate of soda, etc., used singly, have been shown by Spiers (1) to have atomic characteristics which make them poor representations of "average tissue" in so far as the absorption and scattering of x-rays or gamma rays are concerned; this is especially true for the softer radiations. Spiers proposed a mixture of powders, which is a considerable improvement. It is our experience, however, that the large "packing factor" associated with any powder or powder mixture, vitiates the accuracy with which it can be used. A further drawback of the powder form of bolus is a tendency to penetrate almost any bag in which it is contained, thereby scattering dust on the treatment couches and on the patients. Tissue-equivalent wax is satisfactory from the physical point of view but the method requires a great deal of time and labor, since the bolus for each patient must be specially moulded. Water bags are good from a physical standpoint, provided the water-proof bags are thin enough not to interfere with scattering and absorption. There is, of course, the danger of leakage, and the bags should be warmed thoroughly before application to a patient.

The object of the study described herein was to provide a bolus material for clinical use which would be free from variations due to incorrect packing, clean and convenient to use, and a really accurate representation of average human tissue, for a wide range of x-ray qualities. The new material developed as a result of this work consists of approximate spheres, about 2 mm. in diameter, made from 87 per cent sugar (sucrose) wt./wt. and 13 per cent magnesium carbonate levis wt./wt. The mixture of solid spheres and air interstices provides the desired tissue equivalence and the product is used as shown in Figure 1. It has the following features:

1. Its packing factor in clinical use is about ± 1 per cent.
2. Its electron density, calculated on the basis of a bulk density of 1.05 gm./c.c., is within 0.1 per cent of that for water and within 1.0 per cent of that for "average human tissue" as proposed by Mayneord (2). In practice the electron density varies slightly from batch to batch, but is always within 1.0 per cent of that of water and 2 per cent of that of "average human tissue."
3. The calculated effective atomic number is well within 2.0 per cent of that for water and within 1.0 per cent of that for "average human tissue," and is, of course, independent of bulk density.

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[1] From Lincolnshire Radiotherapy Centre, Memorial Hospital, Scunthorpe, England. Accepted for publication in March 1952.

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[3] Now at Marie Curie Hospital, London, N. W. 3, England.

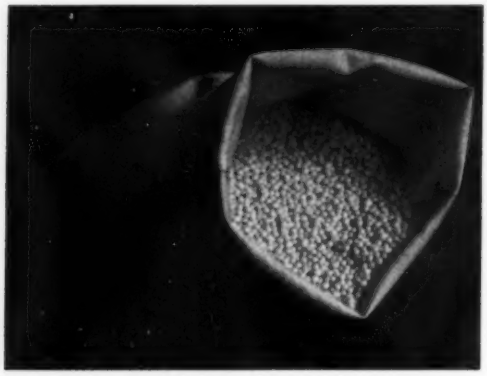

Fig. 1. Appearance of the bolus.

4. These last two factors are responsible for the bolus being a very accurate representation of human tissue at all radiation qualities commonly used in therapy today.
5. The bolus is clean and convenient to use in bags.
6. It is undamaged by rough usage, body pressure, body temperature, humid atmosphere, or prolonged irradiation.
7. The ingredients are readily obtainable and are inexpensive.[4]

CHOICE OF FORM AND ATOMIC CHARACTERISTICS

The form of the bolus was determined principally by the need for as low a packing factor as possible, but also by general practical considerations. Objections to powder, solid wax, and liquid substances have been mentioned above. The remaining practicable form is that chosen, *i.e.*, small discrete particles of millimeter order of size. Experiments carried out with such particles of heterogeneous shapes showed that the packing factor decreases as the particles approach spherical form; particles of random shape and size are little better than powder in this respect. For minimum packing factor the spheres should also have a smooth, hard surface. Accordingly the present bolus particles are made nearly spherical; they are hard, but the surface is not particularly smooth. It so happens that the particular degree of departure from spherical shape and smooth surface attained by the chosen manufacturing process yields exactly the required bulk density. Because of this deliberate choice of a form which is not ideally spherical or smooth, the packing factor is, of course, slightly more than it need be, but it is still trivial compared to that of powders, and it is small enough to ensure results within ± 1.0 per cent in clinical use. Clearly the atmosphere in the interstices has no appreciable influence on the effective atomic number or electron density. All the theoretical work described, therefore, assumes that the spheres are *in vacuo*.

The required atomic characteristics are determined on a basis of the absorption and scattering of x-rays and gamma rays by any substance. It has been shown by Mayneord (2) and Spiers (1) that these are governed by the electron density and effective atomic number of the material.

$$\text{Electron density} = n = N\rho \sum \frac{n_1}{M_1} \quad \text{(I)}$$

$$\text{Effective atomic number} = \bar{Z} = \sqrt[2.94]{\Sigma(a_1 Z_1^{2.94})} \quad \text{(II)}$$

where

N = Avogadro's number.
M_1 = Molecular weight of constituent 1.
n_1 = Number of electrons in molecule of mass M_1
Z_1 = Atomic number of element
a_1 = Fractional content of electrons for element Z_1.
ρ = Density

Mayneord calculated n and $\bar{Z}$ for an assumed average tissue. Using his figures and the latest value of N we find $n = 3.32 \times 10^{23}$ per c.c. and $\bar{Z} = 7.33$. (This compares with $n = 3.34 \times 10^{23}$ per c.c. and $\bar{Z} = 7.42$ for water.) There is, of course, wide variation of n and $\bar{Z}$ from one kind of tissue to another. In designing a new bolus, however, it is necessary to

[4] The ready-made bolus can be obtained from the firm Batger and Co., Ltd., Stepney, London E.1., which has kindly co-operated with the authors and has undertaken the bulk manufacture on a non-commercial basis. One hundredweight is adequate for the needs of a normal treatment center and will last indefinitely.

aim at some particular figure, and the present authors have followed the practice of keeping within 2.0 per cent of the figures both for water and for "average human tissue." This would appear to be the best practical course, and it has the added advantage of enabling direct comparison to be made with the results in water. Water has, in any case, been accepted as tissue equivalent for all radiation qualities routinely employed in therapy today. Spiers has shown how far the absorption coefficient is in error at various wave lengths, for various discrepancies in n and $\bar{Z}$. From the formula for the linear absorption coefficient quoted by Spiers, namely

$$\mu = n({}_e\sigma + 2.64 \times 10^{-26}\bar{Z}^{2.94}\lambda^3) \quad \text{(III)}$$

it can be seen immediately that a small error in $\bar{Z}$ will produce a large error in μ at soft therapy qualities, whereas errors in n will produce a smaller effect, but one that will be constant at all qualities. The bolus was therefore designed to be as accurate as possible, both in effective atomic number and in electron density.

CHOICE OF METHOD FOR QUANTITY PRODUCTION

It was desirable to choose the best method for quantity production before specifying the ingredients, since there was likely to be considerable latitude in the selection of the latter, as will appear later. Several methods of production were examined. An average user would probably require a number of spheres of the order of 10^7. The problem, therefore, was to find a manufacturing process which would yield such numbers cheaply and efficiently and be amenable to the introduction of the specified ingredients. It was felt that the makers of plastic bearings might be able to produce large quantities of a prescribed mixture of plastics. The complex and sometimes secret chemical formulae of such substances, however, would have made the specification of the prescription mathematically impracticable. Also, the initial production costs would be prohibitive. Another production method, suitable for laboratory use, was to drop molten wax mixtures into cold water, but the resulting shapes were unacceptable, and the rate of production entirely inadequate. Yet another proposal which proved abortive was that manufacturers of small beads might be able to use suitable ingredients. The final successful line of approach sprang from the suggestion that the manufacturers of sweets such as "hundreds and thousands" might be able to incorporate suitable ingredients. This was found to be quite practicable; the manufacturers can produce several hundredweights of bolus in one operation lasting a matter of days. Sweets of this nature are usually made from pure sugar with a trace of coloring matter and a little starch or gelatin to assist in the manufacturing process. It was found that these binders could be omitted at only slight sacrifice in perfection of size and shape (which actually proved to be advantageous). The manufacturers anticipated little difficulty in making quantities to any prescription, provided only that it contained a high proportion of sugar and no poisonous materials, and that the added substances should be either soluble in water or of a nature suitable for preparing a uniform suspension in sugar syrup.

CHOICE OF INGREDIENTS

A list of substances suitable from the manufacturing point of view was kindly prepared by the British Food Industries Research Association. It was first assumed that it might be necessary to add two other substances to the sugar, as the conditions expressed by Equations I and II have to be fulfilled, and the total percentage (wt./wt.) of the ingredients must be 100. The process was one of mathematical trial and error, assuming different added substances and calculating the necessary contributions. After several trials it was found that 87 per cent sugar and 13 per cent magnesium carbonate levis, with no third substance, would give the correct n and $\bar{Z}$ if the bulk density

were 1.05 gm./c.c., a value which can be attained with certainty by appropriate control of the manufacturing process.

This combination was extremely fortunate, as it meant the use of only two ingredients, with sugar greatly preponderant. The magnesium carbonate levis is nonpoisonous, inexpensive, and easily obtainable in an adequately pure form which makes a uniform suspension in sugar syrup.

The sugar used is practically all sucrose, $C_{12}H_{22}O_{11}$, but calculation of n and $\bar{Z}$ shows that the substitution of glucose, $C_6H_{12}O_6$, or of invert sugar makes no difference. The magnesium carbonate is "magnesium carbonate levis" of B.P. purity, with the formula $3MgCO_3Mg(OH)_23H_2O$. Here again calculation shows that small variations in the relative proportions of hydroxide and water are of no significance.

GENERAL NATURE OF THE MANUFACTURED PRODUCT

The manufacturing process necessitates a pure sugar granule at the center of each sphere; more sugar is coated on to this granule until it acquires a spherical shape. The spherical base thus obtained is then coated with the special mixture described above. The percentage of magnesium carbonate in the outer part of the sphere is increased to give the desired proportion of ingredients in the average complete sphere. The mass of the center portion (containing no magnesium carbonate) is only about one-eighth of the mass of the complete sphere. The presence of the pure sugar granule at the center is not regarded as in any way disadvantageous, as the bolus is always used in quantities consisting of very large numbers of spheres. It is only necessary that the over-all reaction to radiation of many spheres interspaced by atmosphere should simulate average tissue. In practice, as pointed out above, the bolus does not consist of perfectly shaped or ideally smooth spheres, nor are the sizes uniform; these two facts have a practically negligible adverse effect on packing factor but ensure attainment of the required bulk density. The bulk density, measured in a 250-ml. flask, is between 1.05 and 1.07 gm./c.c., which in clinical use yields the required electron density of 3.34×10^{23} per c.c. The actual manufacturing variations as to shape and size which are found to occur under careful control are unimportant. Variations in content of magnesium carbonate levis between 12 and 14 per cent (wt./wt.) are permissible; repeated analysis during manufacture insures that these limits shall not be exceeded.

Both sugar and magnesium carbonate levis are obtained in a very pure state. A sample of magnesium carbonate B.P. was analyzed, and it was found that trace impurities of heavy metals in the latter were not sufficient to influence $\bar{Z}$ by as much as 0.1 per cent. It would require a thirty-fold increase in lead content to produce a 1 per cent effect, while the maximum increase within pharmaceutical standards is 2.5 times. Similarly it would require a ten-fold increase in iron impurity, whereas no increase is permitted. It appears, therefore, that variations in impurities in successive batches of chemicals could not be great enough to change appreciably the properties of the material.

Changes in water content dependent on local heat and humidity have also been investigated. A comparison was made between a new batch of the material, a batch from storage some weeks after manufacture and delivery, and a batch which had been subjected to 70°C. and 100 per cent relative humidity for a week. This is worse than anything which would be encountered even in the tropics. The normal batch showed 1 per cent moisture content, the "tropic" batch 2.5 per cent. Changes in n and $\bar{Z}$ due to this variation are entirely negligible.

CHEMICAL EFFECTS OF IRRADIATION

Although there was no reason to expect that chemical effects of irradiation might result in rearrangement of atoms into different molecules which could change the properties of the bolus material, still it

TABLE I: TESTS FOR TISSUE EQUIVALENCE

Voltage	Added Filter (mm.)	h.v.l. (mm.)	Type of Test
45 kv.	None	0.5 Al	Transmission
45 kv.	1 Al	0.7 Al	Scatter and depth dose
45 kv.	2 Al	1.3 Al	Scatter and depth dose
45 kv.	2.5 Al	1.6 Al	Transmission
90 kv.	4 Al	4.3 Al	Transmission, scatter, depth dose
220 kv.	1 Cu + 1 Al	1.8 Cu	Transmission, scatter, depth dose
1 mv.	4.2 Fe, 2 Al, 2 Pb and 2 Al	9.3 Cu	Transmission, scatter, depth dose
Gamma rays of radium	1 Pt		Transmission
Gamma rays of radium	Beam unit		Depth dose

seemed desirable to test this. One sample of the finished bolus was exposed to about 10^6 r of x-rays (h.v.l. 0.3 mm. Cu) over a period of four and a half hours and submitted to the British Food Industries Research Association for analysis. A second sample was analyzed after clinical use in bolus bags for one year. No evidence of any chemical change due to radiation was found in either.

MECHANICAL TESTS

Rigorous tests were carried out in order to determine whether the bolus would stand up to severe conditions in use, such as high temperatures, high relative humidity, rough handling, pressure by the patient's body. In order to simulate a case worse than anything likely to occur in practice, a sample was subjected to each of the following tests in succession:

Irradiation by 10^6 roentgens in four and a half hours; subjection to normal body temperature plus 100 per cent relative humidity, while under body pressure (0.7 lb. per square inch) for one hour; subjection to severe mechanical wear and tear by throwing the bag of bolus from hand to hand for a total of four hours, and deliberately dropping on numerous occasions. At the end of this most severe test, a small amount of powdering and chipping was evident, but the powder and chips amounted to only 2.5 per cent of the total weight. Individual spheres showed no visible distortions such as might be expected from pressure if softening had occurred.

EXPERIMENTAL VERIFICATION OF TISSUE EQUIVALENCE

A very complete series of tests was made in order to verify the tissue equivalence over the whole range of qualities commonly used in radiation therapy today. The qualities of radiation and types of tests are as shown in Table I.

In every case the bolus was packed to an exact bulk density of 1.05 gm. per cubic centimeter by use of a known weight and ensuring that the surface came to a prescribed level. Although the packing variation of this material is so small as to be quite negligible in clinical application, precautions must be taken when the material is used as a phantom, where the degree of accuracy sought is greater.

At each of the qualities listed, the transmission of the bolus was tested for all relevant thicknesses, the scatter produced in the bolus was tested at all relevant depths, and the percentage depth dose in the bolus was tested at all relevant positions. In every case the method of test was to make a direct comparison with water. The values in bolus and in water were obtained with identical apparatus, set up in exactly the same manner, during the same experimental run, almost always on the same day, though very occasionally overnight.

This represents a very large amount of experimental work. All the transmission, scatter, and depth-dose curves are available elsewhere.[5] It is sufficient here to state that in no case was there any difference of clinical significance between the water and bolus. In fact, the agreement between the two substances is far closer than clinical users will require.

[5] At cost, from the Secretary of the Hospital Physicists Association, Diagrams and Data Subcommittee, Physics Department, Mount Vernon Hospital, Northwood, Middlesex, England

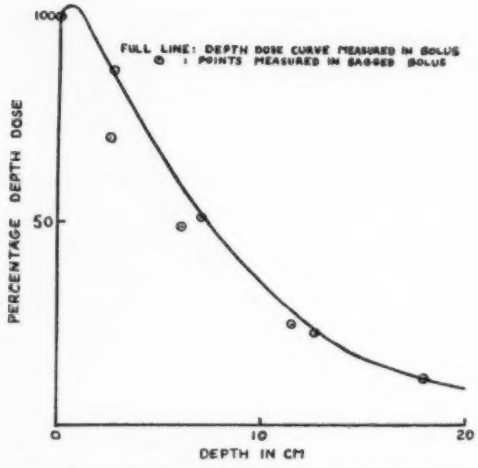

Fig. 2. Demonstration of adequacy of bagged bolus where the bolus material is free from the packing factor and can thus be firmly pressed into position. The points below the line are due to gaps between bags.

USE OF THE MATERIAL AS BAGGED BOLUS

The various mechanical, chemical, physical, and radiation tests described above showed that the bolus was acceptable as a bulk material. It was felt, however, that some investigation should be made of its use in bolus bags of the type and size used clinically at radiotherapy centers. It must be stressed that this represented a test of the habit of using bolus in bags, and not a test of this particular bolus, which has been found to give depth-dose curves indistinguishable from water at all qualities of radiation. A number of bags of different sizes and materials, all containing the new bolus, were packed in a box, and a beam of radiation of h.v.l. 1.8 mm. Cu was used; the primary beam was, of course, well within the box area of 30 × 30 cm., and the depth of the bags was about 30 cm. Depth-dose measurements were taken with a Victoreen chamber and corrected for temperature, pressure, chamber position, and instrument calibration. Readings were taken for different degrees of packing of the bags, from the loosest to the tightest which might reasonably occur clinically. The results are shown in Figure 2. The solid curve represents depth doses measured in unbagged bolus, the points on the line are for bagged bolus closely packed, while those below the line represent inadequate packing of the bags (not of the bolus). Thus it appears that loose packing of bags may lead to appreciable errors; this is clearly applicable to any bolus and is simply a result of having air gaps between individual bags. The degree of pressure necessary to achieve tight packing is not more than may reasonably be applied to a patient. This is shown by the fact that the "loose packing" points also approach the full line at depths of 15 to 20 cm., where they are packed under their own weight. It is therefore possible to recommend that users pack bags of this bolus tightly, knowing that they can thus merely fill in spaces between bags, and that they cannot appreciably compress the bulk of the bolus. If bags of this bolus are always pressed firmly into place, both consistent and correct results should be obtained. There is no sign of any appreciable error due to the space taken up by bag material. Clearly, however, this must be as flexible as possible, as thin as possible, and must not contain anything which absorbs radiation strongly or gives off any serious characteristic radiation. The material "flows" well in bags, and users have found it very convenient during several years of experience. Victoreen measurements on many breast cases treated by the glancing field technic of irradiation have shown that the planned dose is indeed being obtained with this bolus.

FINAL SPECIFICATION

As a result of all the various experiments and tests described above, and of experience in use, it was possible to draw up a final specification to which the manufacturers should work. This is detailed below:

1. The initial sugar granule should be the smallest available and should be a refined high-grade sugar.

2. The sugar from which the syrup is made should be mineral water sugar.

3. The magnesium carbonate levis should be "magnesium carbonate levis of

B.P. purity." Its approximate formula is $3MgCO_3Mg(OH)_23H_2O$.

4. The addition of magnesium carbonate levis should begin as soon as possible in the manufacturing process, in order to keep the "all-sugar" center of each ball as small as possible.

5. The total quantities of sugar and magnesium carbonate levis in any batch are specified as 87 per cent wt./wt. and 13 per cent wt./wt., respectively.

6. During manufacture every precaution should be taken against ingress of foreign matter.

7. No starch, gelatin, or other mucilage should be used in the manufacture.

8. The finished balls should average about 2.3 mm. in diameter and should have the degree of roundness and uniformity of size which is attained by using these manufacturing processes, without the help of any starch or other mucilage.

9. The bulk density measurement should be made on a representative sample, in a 250 ml. relative density bottle. With the bolus shaken down fully, *i.e.*, tightest packing, the bulk density should be between 1.05 and 1.07 gm./c.c., in order to achieve a clinical figure between 1.04 and 1.06 gm./c.c. The material for these measurements should be a bulk sample made up of balls from each of ten different parts of the batch.

10. Every batch should be analyzed before being dispatched to any user. The results should show that the magnesium carbonate levis content is not less than 12 per cent nor more than 14 per cent wt./wt. The material for these measurements should be a bulk sample, as described in the preceding paragraph.

SUMMARY

A new bolus material has been designed and has been in use at the Lincolnshire Radiotherapy Centre for several years. It consists of small hard pellets, practically spherical in shape, and is composed of 87 per cent sugar wt./wt. and 13 per cent magnesium carbonate levis wt./wt. It is a more correct representation of water or average human tissue, at all qualities of radiation, from gamma rays to the softest rays used in therapy, than any other bolus known to the authors. It is, for all practical purposes, free from packing variations. The correct method of working with this bolus is for the operator to press it into position as firmly as possible, ensuring that there are no gaps between bags; no amount of pressure can produce an unwanted high density. The new bolus is clean and convenient to handle, both in bags and in its raw state. It withstands prolonged irradiation, high humidity, body temperature, pressure, and mechanical wear and tear. It enables the dose distribution to be accurately known in all cases (apart from the influence of tissue disuniformities).

ACKNOWLEDGMENTS: The authors wish to express their indebtedness to the following: Dr. J. Z. Walker, past Medical Director of the Lincolnshire Radiotherapy Centre, for the suggestion of using discrete particles, large compared to those in powders; to Dr. J. R. Condon, present Medical Director of the Lincolnshire Radiotherapy Centre, for suggesting the manufacturers of sweets, such as "hundreds and thousands," as a suitable source of quantity production of small spheres, to any required recipe, and for much interest throughout the work; to Mr. H. S. Machin, Mr. F. Hetherington, and Mr. J. Armstrong of Batger & Co., Ltd., without whose splendid co-operation this bolus could not have been produced; to Dr. C. L. Hinton of the British Food Industries Research Association, for suggestions and analyses detailed above; to Professor J. E. Roberts of the Middlesex Hospital, for making the 10 gm. radium beam unit available; to Mr. G. Innes of St. Bartholomew's Hospital, for allowing the use of the million-volt machine and co-operating in the experiments thereon; to Dr. E. Ritter, of the Lincoln County Hospital, for putting the superficial x-ray set at our disposal; to Mr. D. H. Trevena, lately of the Lincolnshire Radiotherapy Centre, for carrying out much of the experimental work; to Dr. Edith H. Quimby for revising the text of this paper for publication in RADIOLOGY.

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SUMARIO

Nueva Substancia para Empleo como Bolo

En la práctica clínica, por virtud de la irregularidad de la superficie del cuerpo con la que choca el haz de rayos, resulta frecuentemente necesario, a fin de proyectar el tratamiento, llenar esas irregularidades con bolsas de substancias componentes de bolos. Una nueva substancia para ese propósito ha sido elaborada en el Centro de Radioterapia de Lincolshire, Scunthorpe, Inglaterra, donde ha sido empleada por varios años. Consiste en pildoritas duras, de forma casi esférica, y compuestas de 87 por ciento de azúcar y 13 por ciento de carbonato de magnesio leve por peso. Representa mejor que ningún otro bolo que conozcan los AA. el agua o los tejidos humanos en general, ante toda clase de irradiación, desde los rayos gamma del radio a los rayos más blandos usados en terapéutica. Para todo fin práctico, se halla exenta de variaciones debidas al empaque.

El modo acertado de utilizar este bolo consiste en que el operador lo comprima en posición lo más firmemente posible, cerciorándose de que no quedan lagunas entre las bolsas; no hay presión que pueda producir una densidad inconveniente por lo alta.

El nuevo bolo es limpio y fácil de manejar, tanto en las bolsas como en bruto. Tolera la irradiación prolongada, la humedad elevada, la temperatura orgánica, la compresión y el desgaste mecánico. Permite conocer con exactitud la distribución de la dosis en todos los casos (aparte del influjo derivado de la falta de uniformidad de los tejidos). Se obtiene sin dificultad en Inglaterra sin fines lucrativos (Batger & Co., Ltd., Stepney, Londres E 1).

Roentgen Hepatography by Injection of a Contrast Medium into the Aorta[1]

Preliminary Report

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THE EFFORT TO opacify the liver for roentgen examination has led to a large number of experiments, most of which have been strikingly unsuccessful. It is possible to introduce a contrast medium into the liver through intravenous injection, but in general the substances which have been useful have either been immediately toxic or have remained in the liver for so long a period of time as to produce deleterious effects. In more recent years, roentgen studies of the veins of the liver, particularly of the portal circulation, have been achieved through a direct injection of branches of the portal vein as described by Moore and Bridenbaugh (7, 8). This procedure, however, requires laparotomy for its accomplishment and is, therefore, of limited value. More recently, Bierman, Steinbach, White and Kelly (1) have studied the portal venous circulation roentgenologically by injection of a contrast medium following percutaneous insertion of a needle through the anterior abdominal wall into the liver substance and thus into one of the branches of the portal vein. Such a procedure obviously is laden with difficulties and has only a limited applicability.

During the course of some cholangiographic studies made a number of years ago (9), it became evident to us that it is possible to flood the liver with contrast substance by way of the circulation. The procedure reported by Moore and Bridenbaugh (7), in which direct injection of the portal vein was made, revealed that, after the introduction of the contrast substance into the portal circulation, the extension of the material into the sinusoids of the liver would after a certain interval produce a diffuse opacification which was suitable for roentgen study. By means of portal venography, metastases could be delineated as defects in the liver substance; obstructions of the portal circulation within the liver were also demonstrable. Experimental studies in rats by Daniel, Prichard and Reynell (2, 3) similarly demonstrated that injection of the portal circulation may well produce complete opacification of the normal liver, which is of such an order as to give readily interpretable roentgenograms.

The recent introduction by one of us of a somewhat modified technic for abdominal aortography (4) gave us opportunity for observation of the hepatic arterial circulation. Furthermore, the roentgen findings indicated that it would be possible, with films made at appropriate intervals, to obtain suitable roentgenograms of the entire liver opacified in this way. The technic differed from that previously used for abdominal aortography in the following respects: (1) the use of 70 per cent Urokon[2] (sodium 2, 4, 6, triiodo 3 acetylaminobenzoate) as a contrast material (6); (2) the injection of 40 c.c. within three seconds by the use of a No. 16 needle and a veterinary syringe; (3) the cephalad direction of the needle; (4) the direction of the needle upward in such a way as to enter the aorta at the level of the eleventh thoracic vertebra. As a result, an unusually brilliant demonstration of the lower thoracic and entire abdominal aorta, as well as of all the aortic branches, was obtained as shown in Figure 1. It is evident from this figure that there is a considerable ex-

[1] From the Department of Radiology and Division of Urology, University of Minnesota Medical School, Minneapolis, Minn. Presented before the Yale Medical Society, April 9, 1952.

[2] The supply of 70 per cent Urokon was furnished us for clinical investigation by the Mallinckrodt Chemical Company of Saint Louis.

Fig. 1. Aortogram to show character of densities produced by the technic described. Roentgenogram made just at the end of the injection.

The hepatic artery (arrow 1), the splenic artery (arrow 2), the superior mesenteric, renal and iliac arteries are well shown. Note the branches of the hepatic artery extending through the liver and the relatively low density of the liver, as compared to the kidneys, at this stage of the procedure.

tension of the medium into the hepatic and splenic arteries by way of the celiac axis. Furthermore, a fairly large quantity can be seen in the superior mesenteric artery, assuring a considerable return of the material through the mesenteric veins into the portal circulation.

Accordingly, we undertook to obtain films as rapidly as possible after the original injection, to demonstrate the liver. Owing to the fact that the aortography was being done primarily for the demonstration of urologic conditions, it was necessary to use 14 × 17-inch films, and for that reason it was difficult to obtain a rapid cassette-changing apparatus. As a result, for most of the original work the cassettes were removed manually from the tray under the Bucky diaphragm table as rapidly as possible. A roentgenogram was made prior to the injection, and a second one immediately upon its completion. In almost all such cases, therefore, some comparison could be made between the density of the liver before the introduction of contrast substance into the abdominal aorta and that which obtained immediately after the arterial injection.

As can be seen from Figure 1, the increase in density of the liver and of the spleen was not usually appreciable immediately at the end of the injection.

Fig. 2. Roentgenogram made four seconds after the end of injection. Arrow 1 indicates the edge of the liver; arrow 2 the edge of the spleen.

Note the opacification of the liver and its density, which compares favorably with that of the more opaque kidneys and is somewhat greater than that of the spleen. This is approximately the degree of density usually obtained under these circumstances in a normal case.

In a third roentgenogram, made from three to four seconds later, however, a distinct and fairly dense shadow of both liver and spleen could be observed (Fig. 2). In normal cases the density of the shadows of the two organs was approximately the same. In certain instances there was some variation in the degree of density, but the relationship of liver and spleen densities was fairly constant. A fourth film, made eight seconds after the injection, in some cases reveals an even greater degree of opacification of the liver. At this time the venous return from the various abdominal organs is quite apparent and usually the portal and splenic veins are readily seen (Fig. 3). Frequently they are visible even on the roentgenograms made three or four seconds after the injection is completed. The opacification

of the portal venous circulation is more striking under conditions in which some obstruction to the flow of the contrast medium into the kidneys occurs. For example, in a case of polycystic kidneys (Fig. 4) an unusually vivid demonstration of the portal venous circulation was obtained.

Fig. 3. Normal liver with portal vein circulation demonstrated by proper timing of exposure. Roentgenogram made five seconds after end of injection. Arrow 1 indicates the portal vein and branches within the liver (1A); arrow 2 the splenic vein; arrow 3 the opacity of the right kidney. Contrast the kidney shadow with the opacity of the liver, which is about normal.

Realizing that the quantity of contrast medium lost into the lower extremities is large, we have experimented with compression bags over the lower aorta and blood-pressure cuffs around the legs. Such devices have increased the intensification of the liver shadow to a minor degree. It is evident that the bulk of the medium extends into the kidneys and a large portion passes on through the iliac arteries into the lower extremities. Nevertheless, a sufficient amount could be obtained within the liver to demonstrate certain abnormalities. It should be emphasized that the opacification of the liver is the result of venous return to the portal

Fig. 4. Roentgenogram made after aortic injection in a patient with polycystic kidneys.
Note the absence of kidney shadows except for the small area of contrast seen in the upper pole of the left kidney (arrow 1), the only functioning kidney remaining. Because of the obstruction to flow into the kidneys, the density of the spleen is greatly exaggerated. An accessory spleen is also shown (arrow 2). Note the well defined portal vein and its branches (arrow 3), and the splenic vein as well (arrow 4). The degree of contrast exhibited by the portal vein is greater than usual, probably because of the obstruction to flow into the kidneys.

circulation from the mesenteric veins as well as of contrast material coming into the hepatic artery.

In a number of cases of cirrhosis of the liver we have been able to show that the opacification is greatly reduced (Fig. 5). This finding corresponds well to the observations of Daniel *et al.* (2, 3), who showed that a dense uniform roentgen opacification of the liver could be produced in the normal rat after injection of the portal circulation with contrast substance, but that, in rats in which cirrhosis of the liver had been artificially produced, the obstruction to the portal circulation prevented such opacification. These workers did not study the arterial circulation.

We have, in addition, been able to demonstrate carcinomatous metastases in the liver as areas of diminished density—in effect, a defect within the contrast-filled liver substance (Fig. 6). This came somewhat as a surprise, since in the case of kidney tumors, for example, the introduction of contrast medium through abdominal aortography causes increased den-

Fig. 5. Hepatography: cirrhosis of the liver. Roentgenogram made four seconds after the end of the injection.

The liver (arrow 1) is small and very low in density. The spleen (arrow 2) is large and much more opacified than the liver. Compare the opacity of the liver with that of the right kidney (arrow 3). Note the good visualization of the splenic vein (arrow 4) and the renal vein (arrow 5) and the poor visualization of the portal vein.

The poor opacification of the liver and of the portal vein is typical of cirrhosis.

Fig. 6. Hepatography: metastasis to the liver from hypernephroma. Roentgenogram made eight seconds after the end of the injection into the aorta, only the liver area being shown.

There is a moderate opacification of the liver still remaining, and within it a fairly large defect (arrows) characteristic of the metastasis, which was later proved. Since the contrast between the area of metastasis and the surrounding liver is not marked, reproduction is difficult.

sity within the neoplasm. Such tumor staining, however, is probably due to an entirely different kind of mechanism. It seems likely that the lack of contrast in an area of metastasis, as well as the general lack of contrast throughout the liver in cirrhosis, is predicated upon the compression of the sinusoids, which does not permit extension of the medium into the liver parenchyma as a whole and thereby reduces its opacification. In the case of the primary tumor of the kidney, the greater opacification is due to the arterial circulation, which has greatly increased capillarity through the tumor, and probably some increased permeability. Studies made in the Department of Surgery by Dr. F. John Lewis (5), using the vinylite corrosion method on the liver removed at autopsy, with injection of the arterial and venous circulation, indicate likewise that areas of metastasis in the liver have rather poor circulation. This, too, is consistent with the findings which we have obtained. A fairly typical illustration of a large metastasis in the liver is shown in Figure 6, a roentgenogram made eight seconds after completion of the injection. The definition of the metastases is not marked and they are difficult to reproduce but are quite readily detected in the roentgenograms which we have made.

Further studies have recently been made with a rapid film-changing mechanism which permits demonstration of these findings more accurately. It is evident from our studies thus far that the time factor is extremely important in the demonstration of metastases, since a lapse of only one second seems to cause disappearance of the contrasting shadows and make the metastases invisible. It is obvious that films made at least at one second intervals would be a very great advantage, and we have under construction at the present time a mechanism whereby this can be readily accomplished with 14 × 17-inch films.

We have reported this procedure in preliminary fashion at this time as a suggestion for a means of roentgen study of the pathology and the pathological physiology of the liver. In many institutions abdominal aortography is now being frequently performed for the purpose of dem-

onstrating tumors or other abnormalities of the kidney or to localize intra-abdominal masses. In the course of each examination, proper studies made at frequent intervals, particularly if a sufficient amount of very highly contrasting substance, such as 70 per cent Urokon has proved to be, may be of great value.

It should be noted that abdominal aortography is not without risk. On the other hand, we have had no more reactions or deleterious effects from the use of the large quantity of medium here injected than have been reported in the several large series of cases in which smaller amounts have been used. The injection of the 11th thoracic segment has the great advantage of avoiding any possibility of entrance directly into the celiac artery, as has been previously reported, and, no doubt, makes the roentgen visualization of the liver and spleen much more effective.

SUMMARY

A method for the roentgen study of the liver is presented.

The rapid injection of 40 c.c. of 70 per cent Urokon into the aorta at the level of the 11th thoracic vertebra has produced reasonably good roentgen opacification of the liver and spleen.

Roentgenograms made at repeated intervals have exhibited the size, shape, and some details of the internal structure of the liver, the hepatic arteries, and the portal veins.

Evidence of the presence of cirrhosis of the liver and of carcinomatous metastases has been obtained.

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SUMARIO

La Roentgenohepatografía por Inyección de un Medio de Contraste en la Aorta: Comunicación Preliminar

Mediante la rápida inyección de 40 cc. de Urokón al 70 per ciento en la aorta al nivel de la lla. vértebra dorsal, resultó posible obtener una opacidad roentgenológica bastante buena del hígado y del bazo. Las radiografías tomadas intermitentemente después de la inyección del medio de contraste revelaron el tamaño, la forma y algunos detalles de la estructura interna del hígado, de las arterias hepáticas y de la vena porta.

En la cirrosis hepática, la opacidad estaba considerablemente reducida. También se descubrieron metástasis carcinomatosas en forma de zonas de menor densidad, que parecían deformidades en la substancia hepática llena del medio de contraste.

Aunque la aortografía abdominal entraña algún peligro, los AA. no han notado más reacciones o efectos nocivos debidos a la gran cantidad de substancia de contraste usada en sus estudios que los comunicados en las varias series de casos en que se han empleado cantidades menores.

Percutaneous Transhepatic Portal Venography

A Preliminary Report[1]

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CONCOMITANT with the recent advances in surgical technics for alleviating hypertension of the portal venous system, there have been many procedures devised for the injection of opaque materials into the hepatic portal vein and its tributaries so that these may be demonstrated on roentgenograms.

Most of the methods have consisted in injection of main tributaries of the portal veins at laparotomy. Contrast media have thus been introduced into a branch of the coronary vein (3), into a small vein of the cecum or mesoappendix (6), into the portal vein with a catheter inserted through the right gastroepiploic vein (10) or a catheter passed through the splenic vein (9, 11), and into the superior mesenteric vein (5).

Approaches to the portal venous circulation without recourse to laparotomy have been made in certain pathological conditions. Fariñas (8) demonstrated the portal venous system roentgenologically after injecting a contrast substance into the long saphenous vein. This was in a case where an anastomosis existed between the inferior vena cava and the portal system. Dotter (7) and his co-workers catheterized the portal vein following a portacaval anastomosis and were able to demonstrate the portal vein and its branches. Celis (4) and his associates injected Nosylan into a prominent periumbilical vein in a patient with portal hypertension and were able to demonstrate the umbilical vein and its connection with the portal vein and the intrahepatic portal system. Abeatici and Campi (1) made injections of Joduron into the spleen of dogs, after which the opaque material was observed on roentgenograms to pass into the tributaries and branches of the portal vein.

We have recently described a method for inserting a needle through the intact abdominal wall into the intrahepatic portion of the portal vein (2). This technic has been used to secure blood samples from the portal vein, to measure the venous pressure, and to obtain angiograms after the injection of a radiopaque material. The present discussion is concerned only with the angiographic studies.

METHOD

The patient is placed in a supine position, inclined upward about 10 degrees. The epigastrium is prepared aseptically, and the tissues of the anterior abdominal wall just below the xiphoid process of the sternum are anesthetized with procaine.

A 16- to 20-gauge needle, 20 cm. long, is inserted through the abdominal wall at an angle of approximately 20 degrees to the right (Fig. 1). If the liver is of average size, the needle is inserted in the transverse plane. If the liver is enlarged, the needle is directed at a 5- to 15-degree angle caudally.

The needle is advanced through the liver until blood can be aspirated or until a depth of 15 cm. is reached. During the passage, aspiration is continually attempted. When blood is freely aspirated, a hemostat is placed about the needle at the skin surface to maintain its position. The patient is told to limit his breathing, because the needle oscillates from the movement of the liver during respiration. Blood samples may then be obtained and

[1] Presented at the Thirty-eighth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 7–12, 1952. Submitted for publication in October 1952.

[2] Department of Radiology, University of California School of Medicine, San Francisco.

[3] Laboratory of Experimental Oncology, National Cancer Institute, National Institutes of Health, U. S. Public Health Service, and the Department of Medicine, University of California School of Medicine, San Francisco.

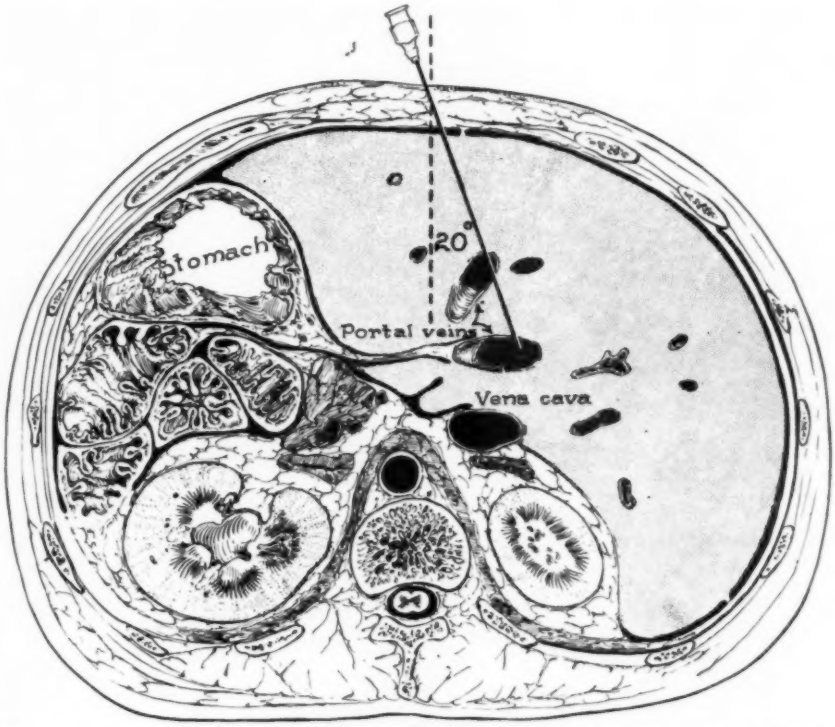


Fig. 1. Cross section at the level of the insertion of the needle for percutaneous transhepatic portal venography. The needle may enter the portal vein or one of its larger branches.

the venous pressure determined. If the needle is aimed 5 to 10 degrees cranially and 10 to 15 degrees to the right, the tributaries of the hepatic vein may be entered.

For venography, a polyethylene catheter with a 50-c.c. syringe containing the contrast medium is attached to the needle. Blood is aspirated once more and injected back into the portal vein to establish the fact that the needle tip is within the lumen of the blood vessel. If the blood does not move freely to and fro without resistance, the position of the needle should be adjusted.

Thirty cubic centimeters of the contrast medium are then injected as rapidly as possible, and a roentgenogram is made at the completion of the injection. This will demonstrate the intrahepatic portion of the portal vein and its branches. If a device is available for obtaining roentgenograms in rapid sequence, the opaque material can be followed until it enters the venous sinusoids, at which time the liver will appear diffusely increased in density.

Both Diodrast and Neo-iopax have been used as the contrast substance. To demonstrate the portal vein, 30 c.c. of 35 per cent Diodrast or 50 per cent Neo-iopax may be injected. If one wishes to produce diffuse opacification of the liver, or a hepatogram, it is necessary to use more concentrated media such as 70 per cent Diodrast or 75 per cent Neo-iopax solutions.

RESULTS

The first percutaneous transhepatic portal venipunctures were made on cadavers. Portal venograms were then obtained on patients with a short life expectancy because of cancer. Following the death of these patients, from their neoplastic disease, examination of the liver revealed the

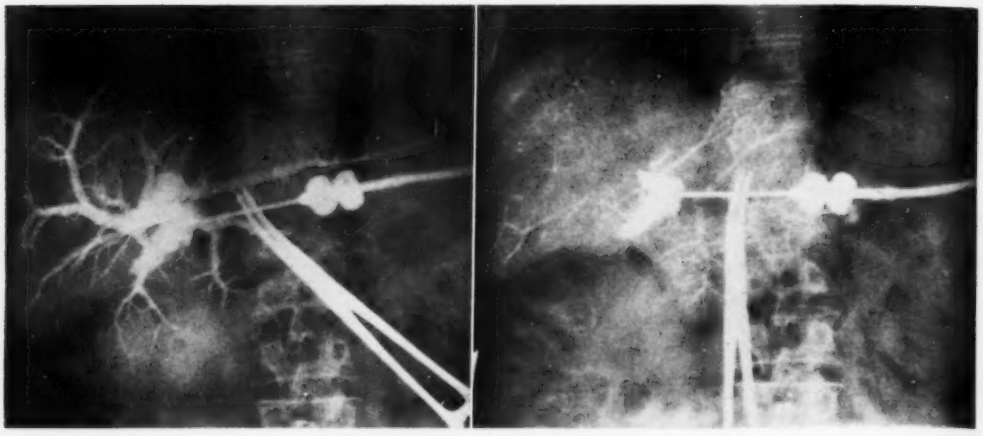
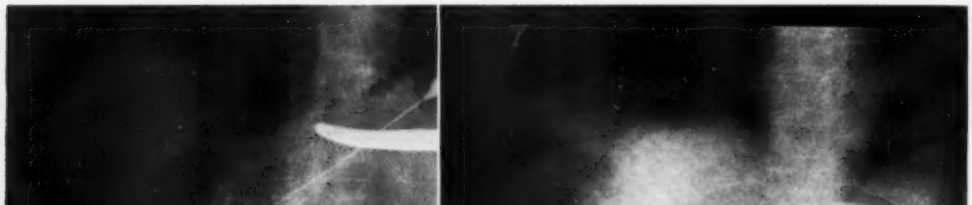


Fig. 2 (left). Normal portal vein.
Fig. 3 (right). Roentgenogram obtained shortly after completion of the injection. The entire liver is increased in density. Some small branches of the hepatic vein are visible.



Figs. 4 and 5. Portal cirrhosis. In both roentgenograms the portal vein is displaced laterally. The main branches of the vein have a narrower caliber and are fewer in number than normal. They terminate in a rich plexus of very small diffusely distributed vessels producing a "stain" or "blush" resembling that seen in vascular intracerebral tumors demonstrated angiographically. There is no evidence of the portal circulation extending to the periphery of the liver.

needle tract extending into a portal radicle without evidence of gross bleeding or liver damage. At the time of writing this report, thirty-five venipunctures had been performed successfully, all by one of the authors (H. R. B.). Venograms have been obtained ten times.

Satisfactory venograms were made on two patients who presented no clinical evidence of liver disease (Fig. 2). These venograms demonstrated the intraheptic portion of the portal vein and its branches to the right and left lobes of the liver. The branching vessels were rather uniformly distributed, and the smaller ones extended to the periphery of the liver. A delayed roentgenogram was obtained on one of these patients, showing the sinusoidal phase, with diffuse opacification of the liver (Fig. 3).

Four venograms were made on patients with advanced portal cirrhosis (Figs. 4 and 5). The venograms of 3 of these patients were satisfactory. All differed considerably from the normal but were similar to one another. The portal vein was displaced laterally. Its branches that were

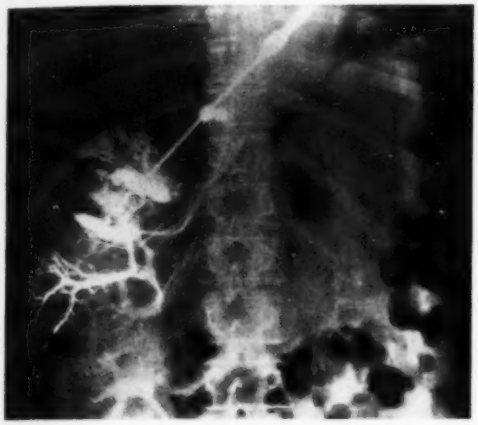


Fig. 6. Metastatic carcinoma from the ovary. There is a marked distortion and displacement of the portal vein and its branches. There are no demonstrable branches of the portal vein to the superior lateral portion of the liver.

filled had a smaller caliber and were fewer in number. They terminated in a rich plexus of very small diffusely distributed vessels which produced a "stain" or "blush" resembling that seen in intracerebral vascular tumors demonstrated angiographically. The vessels were congregated about the main branches of the portal vein, and there was no evidence of the portal circulation extending to the peripheral portions of the liver.

A venogram was obtained on one patient who had metastases in the liver from a cancer of the ovary (Fig. 6). This appeared to show marked distortion and displacement of the portal vein and its branches. No vessels were demonstrated to the superior lateral region of the liver. These abnormalities were more localized than the changes observed in cases with portal cirrhosis. Liver metastases have been demonstrated by others using peroperative portal venography. Child *et al.* (5) demonstrated the neoplastic

Fig. 7. Failure of portal venography. The needle tip was not in the portal vein and approximately 50 c.c. of 70 per cent Neo-iopax was injected into the liver parenchyma. The patient experienced considerable pain during the injection.

mass as a shadow of tissue density surrounded by the opacified liver on roentgenograms taken shortly after the injection had been completed. There was also evidence of some displacement of the veins.

Four venograms were unsatisfactory: one because of technical difficulties encountered with a rapid-changing exposure device; two because the roentgen exposures were delayed until the contrast substance had passed through the liver; the other as a result of injection of the opaque medium into the liver parenchyma (Fig. 7).

On most of the roentgenograms there was evidence of extravasation of a small amount of contrast medium outside of the portal vein (Fig. 8). In one instance, some of the contrast substance had passed from the periportal region to the subcapsular tissues of the lower edge of the liver. The extravasation probably was the result of the needle having been inserted through the far side of the portal vein and then being withdrawn before the venous blood was aspirated. This would leave a defect through which the contrast substance injected under considerable pressure could pass. The patients suffered no obvious discomfort or ill effects from this extravasation. The patient who had an injection of the opaque medium directly into the

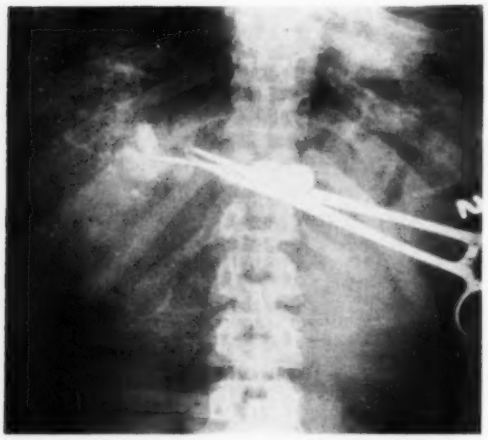


Fig. 8. Roentgenogram taken about three minutes after successful venography. There has been some extravasation of the opaque material into the liver parenchyma. Some can be seen beneath the capsule of the superior surface of the liver.

liver parenchyma experienced considerable pain, which persisted for three days and diminished in the next week.

Much further investigation is necessary before a final evaluation of possible liver damage as a result of this extravasation can be made. One possible solution of this problem is the use of a flexible catheter that could be threaded through the needle and passed into the lumen of the portal vein. It must be emphasized that the aspirated blood should pass easily in and out of the syringe before the injection is attempted.

If, after further investigation, this procedure continues to be safe, it probably would be of use in the study of the physiology of the portal circulation through normal and diseased livers. Portal venography may help observers to understand the altered dynamics of the circulation after portacaval anastomosis and hepatic artery ligation, which are being performed to alleviate the symptoms of portal cirrhosis. It might also become a useful tool in the differential diagnosis of portal cirrhosis, hepatitis, Banti's syndrome, and portal vein thrombosis. The response to the therapeutic measures for cirrhosis may be followed by this means. The presence of space-consuming lesions within the liver could possibly be detected by absence or distortion of the venographic pattern.

Percutaneous transhepatic portal venography would appear to have the following advantages over the previous methods of portal venography.

1. No major surgery is required.
2. The procedure can be performed in the radiographic room, where better radiographic equipment is readily available.
3. The intrahepatic vessels are more clearly demonstrated because the contrast material is injected directly into them. In the peroperative methods, the contrast material mixes with blood from the extrahepatic portal venous system before entering the liver.

The disadvantages associated with the procedure are:

1. Only the intrahepatic portal venous system is demonstrated.
2. There has been some periportal extravasation of the contrast material with the present technic.
3. The method requires that a needle be inserted through the liver parenchyma.

Note: We wish to express our appreciation to Dr. A. Justin Williams for permission to reproduce Figures 4 and 5.

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SUMARIO

Venografía Portal Transhepática Percutánea: Informe Preliminar

Descríbese una técnica percutánea, con la que pueden obtenerse muestras de sangre de la vena porta, medirse la tensión sanguínea (venosa) e introducirse un medio radiopaco para la venografía. Se inserta la aguja a través de la pared abdominal, precisamente más abajo de la apófisis xifoides del esternón, pasándose a través del hígado hasta que pueda aspirarse sangre sin dificultad o que se alcance una profundidad de 15 cm. Para la venografía, se une a la aguja un catéter de polietileno con una jeringa de 50 cc., que contenga el medio de contraste. Se inyectan rápidamente 30 cc. del medio y se toma entonces una radiografía, que revelará la porción intrahepática de la vena porta y sus tributarias. Si hay disponible un aparato que permita tomar radiografías en rápida sucesión, puede seguirse la substancia opaca hasta que penetre en los sinusoides venosos, para cuyo tiempo el hígado revelará un aumento difuso de su densidad. El Diodrasto y el Neo-iopax son los medios de contraste empleados.

Se han obtenido venogramas satisfactorios con este procedimiento, revelando claramente los vasos intrahepáticos. Una desventaja es la ocurrencia de alguna extravasación periportal del medio, aunque no parece ocasionar efectos adversos. En una ocasión, se ejecutó una inyección directamente en el parénquima hepático, motivando dolor que duró varios días.

DISCUSSION

Leo G. Rigler, M.D. (Minneapolis, Minn.): The presentation Dr. Miller has given us is not only an extremely interesting one but I think a very important one. Efforts to make the liver or its various ducts and vessels opaque to x-rays have been numerous and largely unsuccessful, as a clinical procedure. The ingenuity and the courage displayed by the authors of this paper are to be admired, for I suppose one can hardly exaggerate the importance of being able to introduce a contrast medium into the liver circulation. Obviously, most of us would hesitate a good deal about sticking a big needle into the liver in this fashion and poking it around.

I might say that we have been interested in visualization of the liver for a long time and have tried various means to accomplish it. When I saw the preliminary report of Bierman and his associates,[1] published early this year, I rushed over to Dr. Hoffbauer, who is the internist in charge of our patients with liver disease, and suggested that we try it. He said something to the effect that we would do it over his dead body, so I was stymied in attempting this procedure myself.

Nevertheless, according to Dr. Miller's report, there apparently has been no evidence of any deleterious effects. I am surprised at that, since in our experience liver biopsies have occasionally led to some mild degree of bile peritonitis which, of course, is very disturbing in a diagnostic procedure. I am wondering whether that possibility could occur here, and I would like to ask Dr. Miller, in his closing remarks to elaborate as to why they fail to get occasional leakage of bile with the effects which one would expect.

I might perhaps remind you of the work presented before this Society by Drs. Moore and Bridenbaugh[2] from the Departments of Surgery and Radiology at my own hospital. Dr. Moore originally conceived the idea of injecting a contrast medium into the portal circulation at operation. In this procedure, the portal venous system is very well visualized. Dr. Moore was primarily interested in demonstrating the venous circulation

[1] Proc. Soc. Exper. Biol. & Med. **79:** 550–552, March 1952.

[2] Radiology **57:** 685–689, November 1951.

but, after seeing his results, it occurred to us that taking films as rapidly as we could on the operating table, after the injection, might give us diffuse liver opacification because of the ready communication of the veins with the sinusoids. This idea proved to be correct, and good opacification of the entire liver was obtained when films were made at the proper time. In several cases it was thus possible to demonstrate a metastasis as an area of greatly diminished density within the opacified liver. No doubt the sinusoids are obliterated by the tumor; hence the absence of contrast medium in the metastatic area. However, we are not satisfied with this procedure since it is, of course, sharply limited, first, because the x-ray technic is difficult, as it must be done in the operating room, and second, because, it requires that the patient be operated on.

Last year Dr. Krumbach, in our Department of Urology, changed the technic for abdominal aortography in such a way that we discovered that we were getting unsually brilliant visualization of the arteries of the liver and spleen. It occurred to me again that if we took films at the proper intervals after the introduction into the abdominal aorta of the 70 per cent Urokon, which he was using, we might get opacification of the liver and spleen. This result has been achieved and will be reported as a means of roentgen visualization of the liver and spleen.[3]

We discovered that it is rather difficult to do this procedure in patients with cirrhosis because they commonly have a prothrombin deficit and one is reluctant to put needles into blood vessels if one believes that clotting is not going to take place readily. I am wondering whether Dr. Miller has encountered similar difficulty.

I would like again to express my hope that Drs. Steinbach, Miller, and Bierman will continue this work to see how free from risk it may be, for it certainly has the potential of an extremely important contribution to our ability to study the pathology and the pathological physiology of the liver.

F. F. Ruzicka, Jr., M.D. (New York): I believe that this gathering would find it of interest to see still another method of roentgen visualization of the portal venous system. This is a technic to which Doctor Miller referred, namely, percutaneous injection of contrast medium into the spleen.

This method has been described in the literature. In our case, [demonstrated by a slide], 40 c.c. of 70 per cent Urokon was injected directly into the spleen. Some extravasation of dye occurred into the splenic parenchyma. The greater part of the opaque material, however, passed into the splenic vein and then into the portal vein. Normally, only these two veins of the portal system would be visualized. In this instance, however, we have an abnormal circulation in a case of cirrhosis of the liver. The injection of this patient was made during anesthesia but prior to incision. Portacaval shunt was planned because of a diagnosis of portal hypertension.

In contrast to the normal case in which one would see chiefly the splenic and portal veins, two major collateral systems are visualized in the present instance. The inferior mesenteric vein is greatly dilated and, we believe, communicates with the inferior vena caval system *via* its lower branches. The coronary vein is also demonstrated, carrying dye up to the region of the fundus of the stomach, where the fundic vein and then the esophageal veins are visualized. These are markedly tortuous and dilated, representing varicosities. The portal vein is only faintly outlined, but one can clearly make out its branches in the liver, which are rather atrophic in appearance. This confirms the observations of Dr. Miller and also observations which we have made in our own postmortem injections of cirrhotics, namely, that atrophy of the branches of the portal vein within the liver may be encountered in cirrhosis of the liver.

I would like to emphasize that this is not a substitute for Doctor Miller's technic. It is another approach which must be evaluated. The potential dangers of the method have not been fully determined. We have done three injections and two of them have been successful. All cases have been abnormal. The spleen has been removed at operation shortly following injection. No ill effects to the patient have been observed.

Dr. Miller (*closing*): I want to thank Dr. Rigler and Dr. Ruzicka for their very interesting discussions. Concerning bile peritonitis we have not seen it but I suppose it is just because in California we do not have so much gall! Actually the direction of the needle and the absence of extrabiliary obstructive jaundice are apparently important. If the needle is inserted low in the tract, bile is aspirated by the liver puncture. If the needle is inserted high in the region, the hepatic vein will be entered.

Concerning the matter of bleeding when the bleeding tendency is high: The low pressure in the portal vein as compared with that in the aorta would lead to less bleeding from the portal vein than from the aorta, so that the danger from liver puncture would seem to be less than that from aortic puncture under these conditions.

It seems to me we are getting into the time of long needles, and it may be that the 1950's will be remembered as the era of long needles. We are certainly using long ones in the aorta, in the spleen, in the liver, and of course we have used long needles for exploration of the brain for a long time.

[3] See page 363 of this issue of RADIOLOGY.

Foreign Bodies in the Kidney

A Review of the Literature and Reports of Four Additional Cases[1]

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FOREIGN BODIES in the kidney and renal pelvis are reported so rarely that we should be reminded of their clinical symptoms and roentgen signs. This subject is not discussed in standard textbooks and few physicians are well acquainted with the entity. A study of the *Quarterly Cumulative Index Medicus* reveals only 34 cases reported in detail. In several of these it was the radiographic examination that disclosed the cause of obscure septicemia or urinary symptoms. Twenty-six of the reports were available for review and 4 new cases will be reported.

Foreign bodies may reach the kidney by one of three routes: through the urethra, bladder, and ureter; from the gastrointestinal tract; by means of external violence. It is well known that foreign bodies are frequently introduced into the urinary bladder. If the object is small enough, it is entirely possible for it to enter the ureteral orifice and ascend to the renal pelvis by means of antiperistaltic action of the ureter. A foreign body may be started on this path by an erotogenic act, by a mentally disturbed patient, or even during an operative procedure. A more frequent and more bizarre route is taken by the foreign body that is swallowed and eventually perforates the intestinal wall at the second portion of the duodenum or after entering the colon. The majority of foreign objects reach the kidney directly as a result of external violence. Postoperative drains should be included in this group, as well as bullets, shell fragments, needles, and explosion debris.

Sex and Age Incidence: The 26 previously reported cases of foreign bodies in the kidney are summarized in Table I. Nineteen of the patients were males and 7 females, the preponderance of males being due to the inclusion of numerous war casualties reported in the foreign literature. The ages ranged from two to sixty-one years. The right kidney was involved in 15 instances and the left in 10.

Etiology: As may be seen from the table, most of the foreign bodies reached the kidney directly by means of external violence. Of these, 10 were bullets or shell fragments, 2 were needles, 1 debris from an explosion, and 1 a fragment of a drain overlooked at the time of a pyelotomy.

Eight patients swallowed objects which later reached the kidney. These included 3 bobby pins, 2 needles, 1 hairpin, 1 toothpick, and 1 wire clip. All of these entered the right renal pelvis. Six were shown to have perforated the second portion of the duodenum. It was presumed that the other 2 perforated the ascending colon to reach the right renal area.

In one unusual case (No. 5) a seed-bearing grass straw was found to be the cause of unexplained hematuria. It was considered that this had been introduced through the urethra, had passed through the bladder and then ascended the ureter to reach the left renal pelvis. In a similar case (No. 11) a single seed-bearing grass straw had been in the right renal pelvis for fourteen months. In a third case (No. 13) it was assumed that a toothpick fragment was introduced into the upper urinary tract during cystoscopy, the explanation being that a toothpick is frequently used as a catheter plug.

Symptoms: Seventeen years was the

[1] From the Department of Radiology of Euclid-Glenville Hospital and of Western Reserve University School of Medicine, Cleveland, Ohio. Presented at The Fourth Inter-American Congress of Radiology, Mexico City, Nov. 2–8, 1952. Accepted for publication in January 1952.

TABLE I: REPORTED CASES OF FOREIGN BODY IN THE KIDNEY

	Author and Year	Sex and Age	Foreign Body and Duration	Mode of Entrance and Side Involved	X-ray Findings	Operation and Result	Presenting Signs and Symptoms and Remarks
1.	Haberen 1913	M 24	Metal, 2 × 1 cm. 7 weeks	Mine explosion Left	Radiopaque shadow over upper pole of kidney	Nephrostomy Recovered	Gross hematuria
2.	Fullerton 1917	M ?	Bullet 14 days	War casualty Right	Stereo films: bullet in posterior pelvis	Type unknown Result ?	Emphasizing stereo studies. Ureteral catheter placed
3.	Fullerton 1917	M ?	Shell fragment Duration ?	War casualty Side ?	Stereo films localized, 3 foreign bodies	Autopsy	Stereo localization accurate as in case above
4.	Scheyer 1921	M ?	Grenade splinter 3 years	War casualty Left	2 unidentified foreign bodies; enlarged kidney	Nephrostomy Recovered	Calculus removed in addition to grenade splinter
5.	Brattström 1927	M 13	2 grass straws, 6 cm. Time ?	Urethra Left	Normal renal outline. No calculus or foreign body. No urography	Nephrectomy Recovered	Hematuria following fall 3 days before
6.	Flörcken 1928	M 36	Bullet 3 years	War casualty Left	Large calculus surrounding bullet in pelvis	Nephrectomy Recovered	Colic, frequency, and urgency
7.	Von Szabó 1928	M 34	Rifle bullet, 2 × 5 cm. 11 years	War casualty Right	Slight hydronephrosis. Bullet in upper pole	Pyelotomy Recovered	Symptom-free 11 years until onset of renal colic
8.	Blaine 1929	F 42	Broken sewing needle From childhood	Urethra ? Swallowed ? Left	1-cm. calculus around 3-cm. needle in pelvis. Hydronephrosis	Nephrectomy Died 6 days following operation	Weakness, loss of energy, and appetite. Colic since childhood
9.	McCune 1930	F 29	8-cm. needle 2 months ?	External violence self-inflicted Left	Point end of needle inserted 2 cm. in lower pole of kidney	Needle removed; approach ? Recovered	Pain and hematuria. Later patient inserted a second needle for sympathy
10.	Marshall 1931	M 31	Bullet, .38 12 years	War casualty Left	Stag-horn calculus; .38 bullet in major calix	Pyelolithotomy Recovered	Backache, weakness, poor appetite
11.	Waring and Drane 1932	M 37	Seed-bearing grass, 2 × 5 × 0.2 cm. 14 months	Urethra Right	"Shadow" in renal pelvis. Calculus ? Slight hydronephrosis	Pyelotomy Recovered	Pain in right quadrant. Nausea, vomiting, fever, hematuria 14 months earlier
12.	Frankenthal 1933	F 25	Rubber drain, 5 × 0.5 cm. 10 months	Postoperative Right	Pyelogram showed the foreign body in superior pole	Nephrectomy Recovered	Drain overlooked at pyelotomy 10 months before
13.	Senger 1933	M 40	Toothpick 1 year	Per bladder via cystoscopy ? Right	Moderate hydronephrosis. Gas suspected, not foreign body	Pyelotomy Recovered	Pain, hematuria, and chills. Toothpick introduced during cystoscopy ?
14.	Böhm 1934	M 30	Machine-gun bullet, 3 × 8 cm. 15 years	War casualty Left	Bullet in kidney; moved with respiration in serial films	Refused operation Living	Intermittent renal colic for 6 years, which disappeared in hospital

longest period of time a foreign body lay in the renal pelvis or parenchyma. The symptoms produced obviously depended on the duration and position of the foreign body, the formation of encrusting or separate calculi, stasis of urine, hydropyonephrosis, and septicemia. Apparently the amount of encrustation was in direct ratio to the time the foreign body had been present. The symptoms in order of frequency included: pain (dull or colicky), hematuria, frequency, urgency, weakness, temperature elevation, and unexplained pyuria.

Roentgenographic Findings: The roentgen examination is of great importance in the diagnosis of foreign bodies of the kidney and their sequelae. Positive findings were reported in all but 1 of the reported cases (No. 5). Radiopaque foreign bodies were present in 22 cases. The 4 radiolucent objects included 2 grass straws and 2 toothpicks. Calculus formation around the foreign body was described in most

TABLE I: REPORTED CASES OF FOREIGN BODY IN THE KIDNEY

	Author and Year	Sex and Age	Foreign Body and Duration	Mode of Entrance and Side Involved	X-ray Findings	Operation and Result	Presenting Signs and Symptoms and Remarks
15.	Middledorpf 1935	F 39	Sewing needle 3 years	Swallowed Right	Moderate hydronephrosis (right), (horseshow kidney). Needle shown	Nephrectomy Recovered	Pain in right upper quadrant. (OEconomos (21) stated this patient died of peritonitis.)
16.	Friederich 1937	M ?	Grenade splinter Over 15 years	War casualty Right	Metal shadow and calculus about 2.5 × 2 cm. Caliectasis	Pyelotomy Recovered	Pain in costovertebral angle, nocturia, and fatigue
17.	Magoun 1937	F 59	Bullet, .38 17 years	External violence Right	Bullet overlying pelvis. Hydronephrosis. Calculus in ureter	Nephrectomy Recovered	Dysuria; hematuria with pain in abdomen and back
18.	Capon and Wells 1938	F 4	Bobby pin About 10 months	Swallowed Right	Bobby pin overlying right renal pelvis. Nonfunctioning kidney	Nephrectomy Recovered	Frequency, hematuria. Second portion of duodenum perforated
19.	Wilhelmi 1940	M 35	Darning needle, 4.4 × 0.2 cm. 6 months	External violence through loin Left	Hydronephrosis. Foreign body in posterior cortex	Nephrostomy Recovered	Severe renal colic for 24 hours
20.	Boeminghaus 1942	M 30	Paper clip ? 10 years	Swallowed Right	Hydronephrosis. 2-cm. calculus around 2 pieces of wire	Nephrectomy Recovered	Frequency, dysuria. Right perinephric abscess drained 8 years before
21.	OEconomos 1945	M 38	Sewing needle 6 years	Swallowed Right	Slight hydronephrosis. Needle in calculus in pelvis	Laparotomy Recovered	Pain and fever. *Via* duodenum or colon
22.	Landers 1946	M 56	Toothpick 5 months ?	Swallowed Right	Excretory urogram negative except for perinephric abscess	Abscess drained Recovered	Backache for 5 months. Toothpick was in abscess. Perforation of colon?
23.	McEnery and Fox 1946	M 2	Bobby pin 9 months	Swallowed Right	Pyelectasis, duodenopelvic foreign body directed supero-laterally	Extraction through duodenum Recovered	Unexplained pyuria. Second portion of duodenum perforated
24.	Begg 1947	M 61	Shell fragment, 1 × 0.5 × 0.2 cm. 13 years	War casualty Left	Shell fragment overlying kidney, 1928. No other noted	Previous nephrectomy Living	Passed the fragment by urethra 10 years after nephrectomy
25.	Mackby 1948	F 3	Bobby pin Time ?	Swallowed Right	Bobby pin perforating renal pelvis	Pin extracted through duodenum Recovered	Urinary symptoms for 6 months. Persistent albuminuria
26.	Bilger and Greiner 1949	M 5	Hairpin 2 to 3 years	Swallowed Right	Calcification around 2 metallic foreign bodies	Nephrectomy Recovered	Pyuria. Hairpin had penetrated pelvis from colon

cases. Separate stone formation was noted frequently. Caliectasis, pyelectasis, and hydronephrosis were reported in 12 instances, though the incidence was undoubtedly higher than this.

Treatment: Treatment by drugs or antibiotics alone was unsatisfactory. It was found necessary to establish adequate drainage, including removal of the foreign body and associated stone formation. Nephrectomy was performed in 10 instances. Most authorities are in agreement that the less radical nephrostomy or pyelotomy is to be preferred if such procedure is possible.

CASE REPORTS

CASE I: L. E., a 24-year-old white male, veteran of World War II, was readmitted to the Cleveland Veterans Administration Hospital Sept. 8, 1949, complaining of pain in the right costovertebral angle for two weeks. This was considered to be secondary to a right renal calculus which had been demonstrated at an earlier admission. Nephrostomy had been deferred because of a previous left nephrectomy and the patient's poor general condition due to osteomyelitis.

The red blood cell count was 3,900,000; white blood cell count, 8,900, with 92 per cent polymorphonuclear leukocytes; non-protein-nitrogen 48.3 mg./100 c.c. Urine culture revealed organisms of the *B. coli aerogenes* group on numerous occasions. Varying amounts of red and white cells, as well as al-

Fig. 1. Case I. The calculus and caliectasis are demonstrated. The small rubber drain which served as a nidus cannot be distinguished.

bumin, were found in the urine on different examinations. Urea clearance varied from 32 to 50 per cent. The sedimentation rate was 36 mm. in one hour.

Excretory and retrograde urograms (Fig. 1) showed a calculus in the right renal pelvis measuring about 2.0 × 1.0 × 0.6 cm. The superior pole calices appeared normal, but the inferior calices were blunted and rounded as a result of the pyelonephritis.

Cystoscopy was performed shortly after admission and the calculus was dislodged by the ureteral catheter. Following this the temperature gradually decreased to normal from the 39° C. (102.4° F.) noted on admission. The patient was maintained on Chloromycetin while time was allowed for healing of the acute inflammatory process. This period was prolonged because of a recurrent soft-tissue abscess in association with osteomyelitis of the right femur.

On Nov. 14, 1949, a right pelviolithotomy was performed[2] and the calculus was removed from the upper pole calyx with some difficulty. Laboratory analysis showed that the stone resulted from calcareous deposits about 0.3 cm. thick around an elastic foreign body which measured about 1.5 × 1.0 × 0.05 cm. This was considered to be a segment of rubber drain (Penrose type) which had been placed in the wound in emergency treatment of a perirenal abscess secondary to a shell fragment wound of the right flank sustained during combat in Germany in 1944. (On the basis of the history and previous physical findings, this abscess had been completely cured and there was no knowledge of such a drain having been present.)

Postoperatively, the patient was treated with Streptomycin and Penicillin until he could take Chloromycetin orally. Following moderate drainage, the wound healed satisfactorily within two weeks.

Subsequent examinations have shown no recurrence of urinary symptoms, and the disseminated osteomyelitis has responded as satisfactorily as could be expected. An excretory urogram, obtained on May 19, 1950, showed the right kidney to be within normal limits as to size and function. There was slight caliectasis in the lower portion.

Comment: Although this patient was an extremely poor surgical risk, it finally became necessary to remove the calculus (formed around the foreign body) from the pelvis of the remaining kidney. Beyond all doubt the antibiotics were the additional factors which made the operation successful.

CASE II: L. G., A 17-year-old Negro male, was admitted to the emergency ward of the University Hospitals of Cleveland at 11:45 P.M. Jan. 28, 1945. He had been shot during a neighborhood fight.

Physical examination revealed a perforating wound 1 cm. in diameter on the anterior abdominal wall of the right upper quadrant, about 7 cm. from the mid-line. Subcutaneous emphysema was present. The right side of the abdomen was rigid; the patient was unable to void. The blood pressure was 150/90 mm. Hg; heart and respiratory rates were normal. An erect roentgenogram of the chest did not reveal any abnormality. The film of the abdomen demonstrated a bullet overlying the right upper quadrant at the level of the dorsolumbar junction.

Following administration of plasma and normal saline intravenously, the abdomen was explored through a right rectus incision. No perforation could be found in the bowel, but the bullet had perforated the liver. The slight surface bleeding was controlled. Both kidneys were palpated and no abnormality was apparent.

About three hours after admission the patient was able to urinate, at which time gross hematuria was present. An excretory urogram was obtained soon afterward, which showed the bullet in the upper pole of the right kidney, protruding into the superior major calyx (Fig. 2). The intravenous medium was extravasated into the perirenal space. The left kidney was normal. No abnormality was evident on the chest film.

[2] By Dr. James J. Joelson and Dr. Manley L. Ford.

On Jan. 30, 1945, the patient's temperature rose to 40.5° C. (104.9° F.). A film of the chest made with a portable unit demonstrated partial consolidation of the right upper lobe, which was considered to represent a pneumonia. Sulfadiazine therapy was instituted. Because of this pulmonary complication, nephrectomy, or even an exploration of the right kidney, was contraindicated.

The temperature gradually fell, reaching normal by the seventh postoperative day. Urinalyses showed hematuria until the third postoperative day, after which the urine was clear. There was no nitrogen retention and no significant decrease in the red blood cell count.

The patient was dismissed from the hospital on Feb. 20, 1945, with the understanding that he was to return for removal of the foreign body from the right kidney. On readmission, April 5, 1945, he stated that he had been free of symptoms during the interval. Laboratory studies showed urinalysis, white and red blood cell counts, blood urea nitrogen, and phenolsulfonaphthalein excretion to be within normal limits. The excretory urogram revealed good bilateral excretion of the medium. The position of the bullet was unchanged in the upper pole of the right kidney. No radiopaque material passed into the perirenal tissues.

On April 9, 1945, the right kidney region was explored.[3] The foreign body was palpated in the upper pole somewhat closer to the posterior surface. It was surrounded by minimal reaction. The bullet was removed through a radial incision by means of a Stone forceps. The patient recovered and has remained symptom-free.

Comment: It is interesting to postulate whether or not the onset of pneumonia saved the patient from having a nephrectomy. Inasmuch as the initial hemorrhage subsided without incident, the interval allowed for healing appears to have been optimum in the treatment of this case.

CASE III:[4] A 40-year-old plumber was admitted to the Boston City Hospital in 1921 with pain in the right costovertebral angle and frequency of urination.

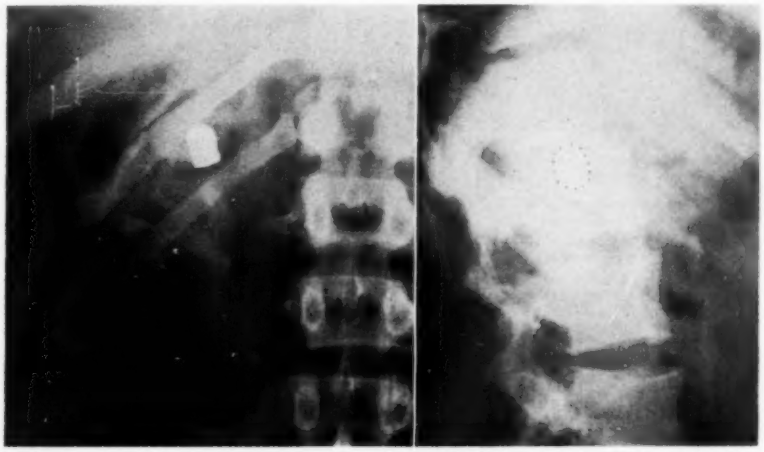

Fig. 2. Case II. Excretory urogram and lateral film showing the bullet protruding into the superior calyx. The medium has been extravasated into the perirenal tissues.

He had been hospitalized seven months earlier with a diagnosis of acute cholecystitis, but radiographic studies of the gallbladder and upper gastrointestinal tract had been reported as normal. No calculus was seen in the region of the right kidney at the earlier admission.

During the second period of hospitalization, urography revealed an opaque calculus in the right renal pelvis. Urinalysis demonstrated numerous pus and red blood cells. The pyelotomy was quite difficult because of the presence of dense adhesions.[5] Inspection of the removed calculus showed a toothpick traversing the center.

Dr. Frank B. Mallory reported that the calculus surrounded a nidus of wood resembling a toothpick with one end apparently chewed (Fig. 3). It was later learned that the patient was in the habit of chewing toothpicks constantly during his work. In Doctor Howard's opinion the toothpick sloughed from the ascending colon into the right renal pelvis.

Comment: This is the ninth case to be reported in which the patient swallowed a foreign body that reached the right renal

[3] Operation performed by Dr. John E. Williams and Dr. Eugene Leiter.

[4] The hospital chart of this patient cannot be located. This report is based on a personal communication from Dr. Herbert H. Howard.

[5] Operation performed by Dr. Herbert H. Howard.

Fig. 3. Case III. Calculus completely surrounding a toothpick, removed from the right renal pelvis.

pelvis. (This case was mentioned by Waring and Drane (25), having been reported to them personally by Dr. J. D. Barney.)

CASE IV: G. B., a 35-year-old white female, was admitted to Glenville Hospital Aug. 24, 1949, during labor. The delivery and early puerperium were normal except for pain in the left costovertebral angle and the presence of 10 to 20 white blood cells per high-power field in the catheterized urine specimen. During the prenatal visits the patient had informed her physician of an operation that had been performed while she was a displaced person in England in 1943. A letter given this patient by the British surgeon read as follows:

"This patient was operated on in April 1943, for an oxalate stone which was embedded in the left ureter 3 inches down from the pelviureteric junction. The stone was removed, as hydronephrosis of the left kidney was taking place. A fistula persisted after the removal of the stone and I closed the fistula by passing a small rubber tube into the lumen of the left ureter. This rubber tube has since migrated up into the pelvis of the kidney.

"It is clear that this tube might give rise to trouble in the future either as a source of infection or, more probably, the starting point for further stones.

"It has been my practice to have a uroselectan done every six months after operation and there has, so far, been no indication for the removal of the tube. The tube is clearly visible on radiological examination and I felt its shadow might give rise to considerable doubt in the interpretation of the pictures if the presence of the rubber tube in that situation was not known."

The pregnancy progressed normally. Four urinalyses between April 30, 1949, and July 21, 1949, were normal. The blood pressure never exceeded 126/78 mm. Hg. No significant edema was present.

Because of the history and symptoms, an excretory urogram was obtained Sept. 2, 1949 (nine days after delivery). This study (Fig. 4) showed good bilateral excretion of the intravenous medium. The anteroposterior and lateral views demonstrated the 4.0 × 0.5-cm. cylindrical foreign body to be vertical in the region of the junction of the pelvis and major calyces of the left kidney. Slight hydronephrosis was present on the left, but none was noted on the right. The erect film showed the left kidney to descend about 6 cm.

Additional studies showed a red blood cell count of 3,650,000, hemoglobin 70 per cent, and white blood cell count 8,900. The blood urea nitrogen was 17 mg. per cent. A culture of the urine showed gram-positive cocci in single and cluster forms. The serum proteins were within normal limits.

The minimal urinary infection responded well to sulfadiazine therapy, and the patient was operated on Sept. 9, 1949.[6] A pyelotomy was impossible because of the presence of severe adhesions around the pelvis and its junction with the ureter. A nephrostomy incision was made in the lower pole and the foreign body (a rubber tube encrusted with urinary salts) was removed in two pieces. Recovery was uneventful and the patient was discharged on the eleventh postoperative day.

A re-check excretory urogram on Dec. 5, 1949, showed normal pelvo-caliceal structures bilaterally. At that time the patient was in excellent health with no recurrence of urinary symptoms.

Comment: The ascent of the rubber tube into the renal pelvis again demonstrates the antiperistaltic action in the ureter. Although the pregnancy might have been a serious complication, only a slight hydronephrosis resulted. No calculus was found other than the encrustation around the foreign body.

SUMMARY

Foreign bodies may enter the kidney by one of three routes: (1) directly, as a result of external violence, (2) by way of the gastrointestinal tract, (3) through the urethra, bladder, and ureter. The majority reach the renal area by direct penetration. Even so, the total incidence is low because of the excellent protection afforded by the structures surrounding the kidneys. Of the 26 cases available in the literature, 14 were due to external violence. Three of the newly reported cases fall into this category. In Case II a bullet entered the kidney in the course of a

[6] Operation performed by Dr. William E. Forsythe.

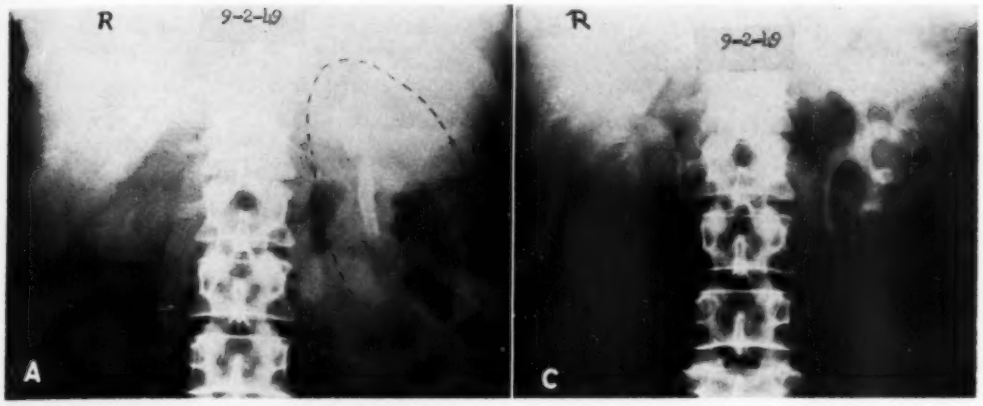

Fig. 4. Case IV. A. Preliminary film of the abdomen showing the encrusted rubber drain in the region of the left renal pelvis. The kidney is somewhat enlarged (dotted lines).

B. Lateral view demonstrating the same foreign object overlying the shadow of the vertebral bodies.

C. The 25-minute film of the excretory urographic study, revealing the intrapelvic location of the tubular foreign body and slight caliectasis.

brawl. In the other 2 cases foreign material had been introduced at operation.

One of the 4 cases recorded here demonstrates the fact that a swallowed object can become a foreign body in the kidney. In this instance a toothpick probably perforated the colon to enter the right renal pelvis. All of the 8 similar cases previously reported involved the right kidney. In 2 of these the colon was the suspected site of perforation. In 6 cases the foreign body failed to negotiate the turn at the fixed second portion of the duodenum and perforated the wall to enter the adjacent renal pelvis.

The most unusual way for a foreign body to reach the kidney pelvis is *via* the urethra, bladder, and ureter. Two such cases (and probably a third) were found in the literature.

The roentgen examination is of great importance in the diagnosis of foreign bodies of the kidney and their sequelae. Radiopaque foreign bodies were found in all but 6 cases. Calculus formation around the foreign body was reported in the majority, and separate stones were noted frequently. Caliectasis, pyelectasis, and/or hydronephrosis were recorded in 14 instances. Positive roentgen findings were noted in 29 of the cases included in this study.

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SUMARIO

Cuerpos Extraños en el Riñón. Repaso de la Literatura y Presentación de Otros Cuatro Casos

Los cuerpos extraños pueden penetrar en el riñón por una de tres vías: (1) directamente, a consecuencia de violencia externa, (2) por el tubo gastrointestinal, (3) por la uretra, la vejiga y el uréter. De los 26 casos que aparecen en la literatura, 14 se debieron a la violencia externa. A esta categoría corresponden también 3 de los 4 casos descritos por el A. En el Caso II una bala penetró en el riñón en el curso de una pendencia. En los otros 2 casos, se habían introducido materias extrañas durante una operación.

Uno de los 4 casos comunicados demuestra que un objeto ingerido puede volverse cuerpo extraño en el riñón. En este caso, un mondadientes perforó probablemente el colon para penetrar en la pelvis renal derecha. Los 8 casos semejantes descritos antes también afectaron el riñón derecho. En 2 de ellos, el colon representaba el sitio en que se sospechó perforación. En 6 casos, el cuerpo extraño no pudo dar la vuelta a la segunda porción fija del duodeno y perforó la pared para penetrar en la adyacente pelvis renal.

La forma más inusual en que un cuerpo extraño llega a la pelvis renal es a través de la uretra, la vejiga y el uréter.

En el diagnóstico de los cuerpos extraños del riñón y de sus secuelas, el examen roentgenológico reviste mucha importancia. En todos los casos, menos 2, encontráronse cuerpos extraños radiopacos. En la mayoría observóse litiasis alrededor del cuerpo extraño y se notaron frecuentemente cálculos separados. En 14 casos, mencionáronse calictasia, pielectasia y/o hidronefrosis. Con excepción de uno, en los 30 casos abarcados en este estudio hubo hallazgos roentgenológicos positivos.

The Radiographic Appearances of Hyaline Disease of the Lungs in the Newborn

A Case Report[1]

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HYALINE DISEASE of the lungs in the newborn infant has received considerable attention in pediatric and pathologic circles, but a careful search of the radiologic literature has failed to reveal similar studies of a radiographic nature. In the case to be reported here, two successive radiographs of the chest at intervals of several hours were obtained in a newborn infant who died after thirty-two hours. This single case is presented in the hope that the description of the findings will stimulate others to carry out radiographic studies. It is possible (at least theoretically) that we are dealing with rather characteristic changes which, with the clinical findings, may contribute to the objective diagnosis of this condition during life.

"Hyaline disease" of the lungs in the newborn infant is characterized by the presence of membranes which, lining the alveolar ducts or alveoli, prevent the proper oxygenation of the blood, so that the infant dies of asphyxia shortly after birth. This membrane has been variously called an "asphyxial" (1–3), "hyaline" (4–6) or "vernix" membrane (7, 8).

Several theories as to the origin of the membrane have been offered. Johnson and Meyer (5) first reported (1925) the condition and attributed it to vernix caseosa inhaled with the amniotic fluid *in utero*. Farber and Wilson (4) also considered the membrane to be formed by the forced inhalation of amniotic sac contents. Actually, according to Farber and Sweet (9), the term "hyaline membrane" is a misnomer and the material has the appearance of vernix within which cornified epithelial cells are tightly pressed. The involved air sacs are usually more dilated than the surrounding alveoli. The membrane (with the exception of its amniotic sac contents) is similar to the hyaline membranes of influenza, *Streptococcus hemolyticus* and perhaps other pneumonias, a finding which first attracted the attention of Johnson and Meyer. Miller *et al.* (2, 10, 11), on the other hand, believe that these membranes represent a reaction to an injury to the epithelium of the air spaces, especially the bronchioles and alveolar ducts. The hyaline membrane is phagocytized by polymorphonuclear leukocytes and mononuclear cells.

Miller and his associates also showed that there was no statistical relationship between the incidence of hyaline membrane formation and parity of the mother, mother's age, duration of labor, the interval between the rupture of the mother's membranes and the birth of the infant, the type of anesthesia or analgesics used, or the method of delivery including cesarean section. In no infant dying after ninety-six hours of age was this change in the lungs observed, but in infants weighing over 1,000 grams dying in the first forty-eight hours of life, there was a 65 per cent chance that a hyaline membrane would be found. In 9 cases in which the diagnosis was unequivocal and hyaline disease was the cause of death, respiratory difficulty was marked at some time during the few hours of life, with laborious breathing and retraction of the lower chest on inspiration. Physical examination in these cases revealed fine râles, varying amounts of localized dullness to percussion, and suppression and exaggeration of breath sounds. There were no pathognomonic symptoms or signs, however.

[1] From the Departments of Radiology, Anatomy, and Pediatrics, University of Arkansas School of Medicine, Little Rock, Ark. Accepted for publication in May 1952. University of Arkansas Research Series No. 980.

Tregillus (13), after a study of 120 stillborn infants and 124 who died in the hospital shortly after birth, believed that he could distinguish the hyaline membrane (asphyxial membrane) from the vernix caseosa. He also believed that anoxia prior to birth was the primary cause of necrosis and hyalinization of bronchiolar epithelium, and that the necrosis gave origin to the "hyaline membrane." This phenomenon occurs more readily in immature infants, although not exclusively so, and starts a vicious circle in which the greater the anoxia, the greater the necrosis of the epithelium. Tregillus regarded the presence of the vernix caseosa as incidental and without a significant role in this disease.

Despite these numerous studies, the literature is notably lacking any account of the radiographic changes in this condition. It is possible that it is included among the cases described by Caffey (14) as "disseminated neonatal atelectasis," but, as will be apparent later, we feel that this condition should be distinguished as a separate entity, so long as its etiology remains unknown and its pathogenesis apparently distinct.

CASE HISTORY

A female infant was delivered by cesarean section, under caudal anesthesia, at 2:00 P.M., July 6, 1950, after a few labor pains. The mother was a 30-year-old physician, and this was her fourth, and most normal, pregnancy. Fetal movement had been felt early, and the fetus had been active thereafter. The mother had a mitral stenosis due to rheumatic heart disease and throughout the latter part of her pregnancy had experienced dyspnea on slight exertion. Her children had suffered from a virus infection when she was six weeks pregnant, but she apparently did not contract this nor did she have any major illnesses during her pregnancy. On numerous occasions, however, she took penicillin, in doses of 1.0 c.c. intramuscularly, for pharyngitis, and once she used penicillin powder by insufflation. This was followed by a severe local reaction of the tongue, characterized by soreness, redness, and a smooth, shiny appearance, lasting for a period of two weeks. She had taken, also, an unknown amount of a sulfa preparation prior to having some dental work done.

The obstetrician aspirated the baby's mouth and exposed the face as soon as the uterus was opened, so that there was little chance of aspiration of amniotic fluid. The cord was allowed to pulsate for several minutes before clamping. Respiration was spontaneous immediately, and the child cried lustily. It weighed 5 pounds and 4 ounces, and its color was good when it was taken into the nursery. There the trachea was aspirated with a tracheal catheter. Physical examination revealed no abnormalities except unusually rapid respiration. There was no retraction of the interspaces, and respiration did not appear labored or especially difficult.

The infant was placed immediately in an incubator and given oxygen. It received penicillin prophylactically (150,000 units aqueous penicillin G) at twelve-hour intervals starting five hours after delivery and was given three doses of vitamin K (Synkamin: Parke-Davis), 0.5 mg., at intervals of six hours. Nothing was given by mouth for twenty-four hours and no parenteral fluids were administered. The face and buttocks were cleansed of vernix, but otherwise no bathing was performed.

At 4:00 A.M., July 7, fourteen hours after delivery, brief cyanotic attacks occurred which were apparently relieved by gentle pharyngeal suction with a bulb syringe and stepping up of the concentration of oxygen in the incubator. At 6:00 A.M., the infant had a very severe cyanotic attack, following which roentgenograms of the chest were taken. These showed partial atelectasis of the right lung, with a shift of the mediastinum to that side. The radiologist reported verbally to the pediatrician (V.H.G.) that he felt the left lung fairly well expanded.

For the next two hours the infant cried lustily so that, if full expansion of the lungs could take place, it would certainly have done so. Four hours after the first chest films were obtained, a second examination was made, and the radiologist reported the mediastinium in the mid-line, with further expansion of the right lung. The baby's condition, however, became progressively worse. Cyanotic attacks increased in frequency, and death ensued thirty-two hours after birth, in spite of tracheal catheter suction and administration of oxygen directly through the tracheal catheter by the Torpin insufflator.

About three hours before death, the left arm became purple and edematous. Because of the atelectasis on the right, the baby had been kept on her left side during much of her brief life, and the question arose in the mind of the examiner whether the cyanosis of the arm might not be due to compression of the left axillary vessels or a possible thrombus.

The past maternal history is relevant and of particular interest in view of the outcome of this case. The first child, although delivered by cesarean section because of premature rupture of the membranes with consequent prolapse of the cord, did well from the start and was in an incubator receiving oxygen for only twenty-four hours after delivery. The second pregnancy terminated at seven and a half months, after a thirty-hour test of labor and even-

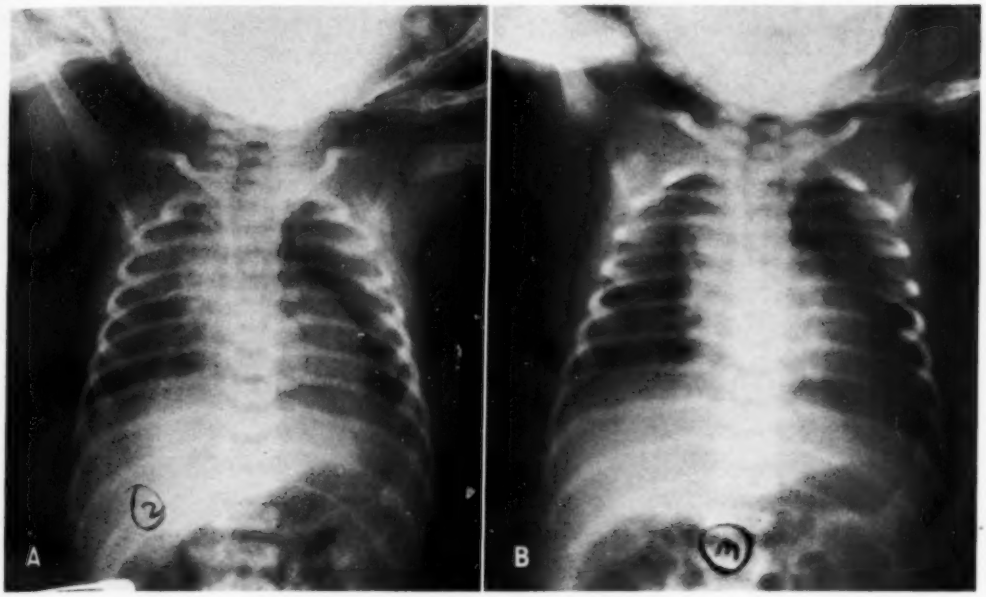

Fig. 1. A. Chest film obtained shortly after birth. B. Chest film obtained four hours later. See text for description.

tual cesarean section. A nurse gave the mother pituitrin by mistake, before the head was delivered, and the baby became very cyanotic. Respirations after delivery were slow, 4 to 6 per minute, and the infant was full of mucus. The weight was 4 pounds and 15 ounces. This child had some atelectasis for a time and marked retraction of the lower sternum, with an increased respiratory rate. It was well, however, at four years of age. The third pregnancy terminated in 1949 at two and a half months, on an automobile trip. A dilatation and curettage were performed after this, and the fourth pregnancy began a few months later.

Roentgen Studies: Anteroposterior films of the chest in inspiration and expiration were made with a mobile x-ray unit and showed a marked shift of the mediastinum into the right lung field. There was a homogeneous increase in density of the right upper lung field (Fig. 1A) with slight, spotty aeration. The lower half of the right lung field and almost the entire left lung field were radiolucent. A small segment of the left upper lobe did not appear aerated. There was a very slight narrowing of the right interspaces and elevation of the right hemidiaphragm.

Films taken approximately four hours later (Fig. 1B) showed improved aeration on the right, although a moderate shift of the trachea and mediastinum to the right persisted. The radiolucency of the left lung field also tended to improve. There remained, however, a patchy mottling throughout both lung fields.

Impression: "Atelectasis, largely localized to the right upper lobe, with some improvement over a period of several hours. Patchy areas of segmental atelectasis also throughout both lungs. In considering etiology, a congenital abnormality of the lungs or mucous plugs must be considered. The possibility of a superimposed incipient bronchopneumonia cannot be excluded."

Gross Autopsy Findings: The pertinent findings included the edema and cyanosis of the entire left arm described above; continuous drainage of a small amount of serosanguineous fluid from the mouth; severe edema of the meninges; a 2-mm. subcapsular hematoma in the thymus, which was otherwise normal. The lungs were dark red in color and, except for small localized areas, were completely atelectatic. Only a small portion of the anterior margin of the middle lobe of the right lung and the medial margin and lower pole of the upper lobe of the left lung were aerated. A conservative estimate would place the proportion of aerated lung at 5 per cent, with the rest atelectatic. The color of the lungs was strongly suggestive of marked vascular congestion with some interstitial involvement. The adrenals were normal in appearance and relationships, but their combined weight was about two-thirds of the normal for the body weight.

Microscopic Study: Microscopic sections of the *lungs* (Fig. 2) from five blocks (two in Zenker's and three in formalin) showed the same histologic picture. Atelectasis was quite uniform throughout and seemed to be alveolar in type. The structure of the tissue was such that it is safe to conclude that the

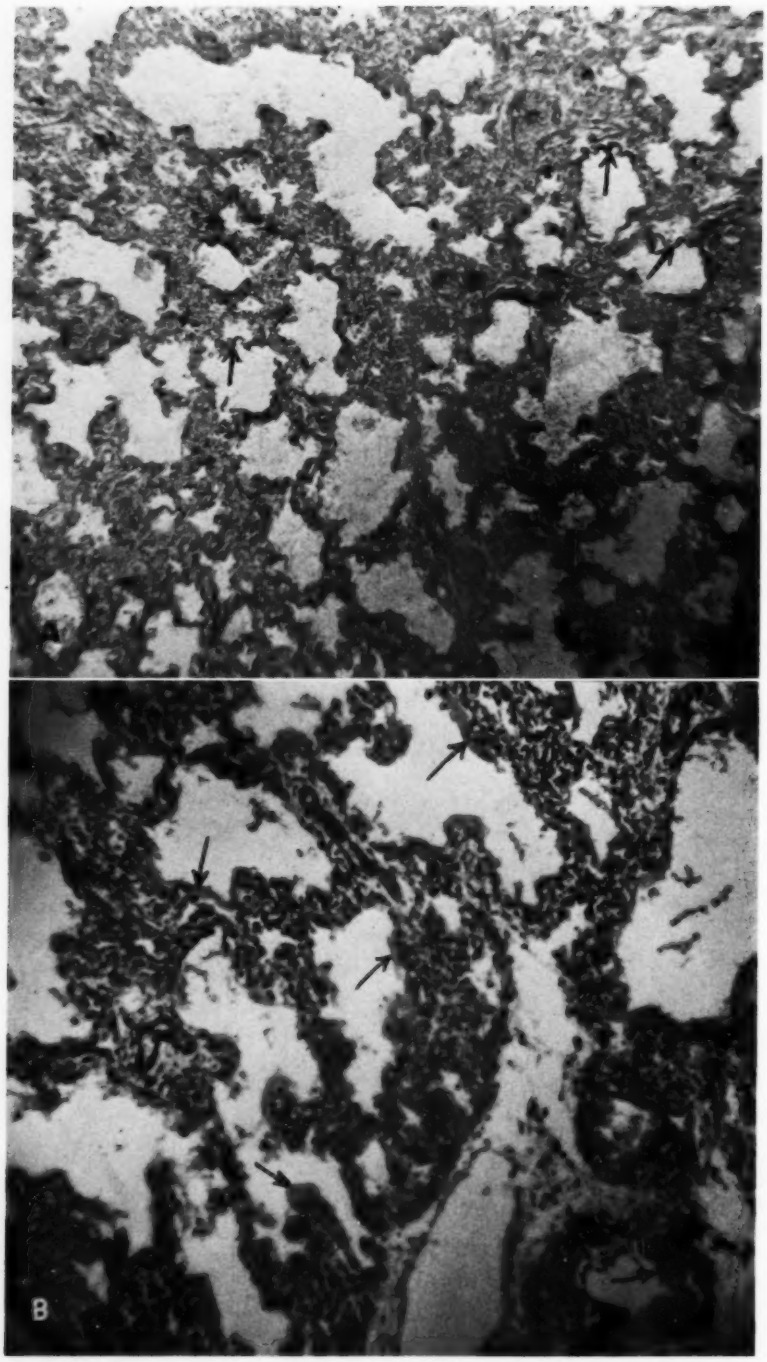

Fig. 2. A. Low-power view of the lung. Arrows indicate the hyaline membrane present in the alveolar ducts. The scarcity of dilated alveoli is clearly apparent.

B. High-power view of the same section, showing the hyaline membrane (arrows). At this magnification a few alveoli can be seen which are only partially expanded, if at all.

atelectasis resulted from incomplete expansion rather than secondary collapse. The bronchioles and alveolar ducts were dilated and the majority were clear of material. Small numbers of red cells were seen in some lumina, but these could well have been the result of the bronchoscopy rather than of non-traumatic hemorrhage. The septa were very thick, but this thickening did not seem to be the result of increased collagenous fibers, as shown by connective-tissue stains. Most of the cavities were lined by an eosinophilic membrane which was non-collagenous, and consistently superficial in position. In the substance of the septa, many small spaces were seen, some having hyaline membranes. These can logically be interpreted as unexpanded alveoli.

Many of the pulmonary lymphatics were distended with an albuminous material. The veins and larger arteries were not unusual. Some of the arterioles were excessively contracted, the endothelial nuclei were closely packed, and the muscular wall was somewhat thickened. The pleura seemed to be thickened, but the unexpanded nature of the lung must be considered in evaluating this finding.

Sections of Zenker-fixed *liver* showed congestion of the vascular sinusoids. A normal number of hematopoietic islands were seen. The nuclei and cytoplasm were somewhat chromophobic, and the cell membranes of the hepatic cells were not distinct. Large vacuoles, presumably fat, were seen in the cytoplasm. These changes were interpreted as an early degenerative manifestation of pathologic importance rather than as due to delayed fixation.

The *stomach* tissue was cytologically well preserved in contrast to the liver. Parietal cells were seen. Considerable interstitial hemorrhage was present in the tunica propria.

Sections of Zenker-fixed *spleen* showed considerable congestion, with a relative reduction of white pulp and lymph nodules. The erythrocytes were laked in the sinusoids, suggesting that the changes may have occurred over a period of several days rather than in the thirty-two-hour postnatal period.

Apart from the stomach, the alimentary tract, pancreas, adrenals, reproductive tract, and heart were normal.

Sections of Zenker-fixed *kidney* were of considerable interest. There were two areas of infarction in the medullary region characterized by dilatation and engorgement of the vascular channels, interstitial hemorrhage, hyalinization of the tubules, and the presence of discrete erythrocytes in the tubular lumina.

Autopsy Summary:

1. Practically complete alveolar atelectasis of both lungs, but considerable dilatation of atria and alveolar duct segments.
2. Hyaline membrane in aerated spaces of the lungs.
3. Marked eosinophilic hyperplasia of the thymus
4. Generalized congestion of the liver and spleen.
5. Localized congestive infarcts of the kidney.

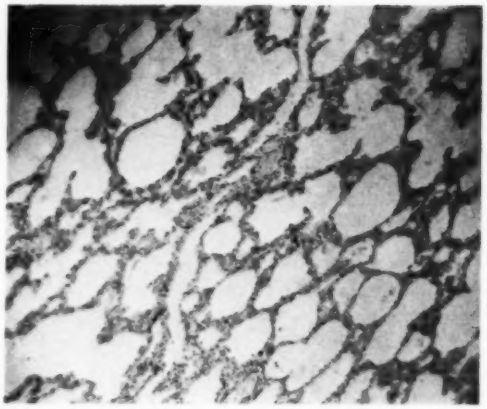

Fig. 3. Low-power view of the lung from a baby dying about thirty hours after delivery for comparison. This section shows reasonably normal dilatation of the alveoli in the absence of hyaline membranes.

DISCUSSION

The correlation of the gross and microscopic pathologic picture with the radiographs in the foregoing case is most significant. The respiratory embarrassment was caused not by a massive or segmental atelectasis of the lung as a whole but rather by a partial collapse of the primary lobule and a coating of the epithelium of the patent portions by a hyaline membrane (Fig. 2B). Thus, although aeration of the lobules is apparent microscopically (Cf. Figs. 2 and 3), the respiratory area was virtually annihilated by two factors: (1) Those structures of the primary lobule which are most efficient in gaseous interchange, *i.e.*, the alveoli, were collapsed. (2) The rest of the lobular epithelium, which could conceivably aid in the interchange of gases, was hampered by the diffuse hyaline membrane. It is conceivable that artificial respiration, while it may have opened up more primary lobules, may at the same time have forced the hyaline membrane into the lobule, which theoretically would still prevent adequate gaseous interchange.

The radiographs depicted the adequate aeration of the terminal (respiratory) bronchioles and alveolar ducts (Fig. 4), and this aeration concealed the collapsed atria,

alveolar sacs, and alveoli. The dilatation of the terminal bronchioles probably did not bring about improved gaseous interchange for the reasons mentioned above. This apparent paradox of an improved radiographic picture on the one hand and the progressively increasing respiratory sensitivity phenomenon in the infant must be entertained, at least until the etiology of this condition is better understood.

DIFFERENTIAL DIAGNOSIS

Asphyxia in the newborn may be related to a variety of conditions. We shall dis-

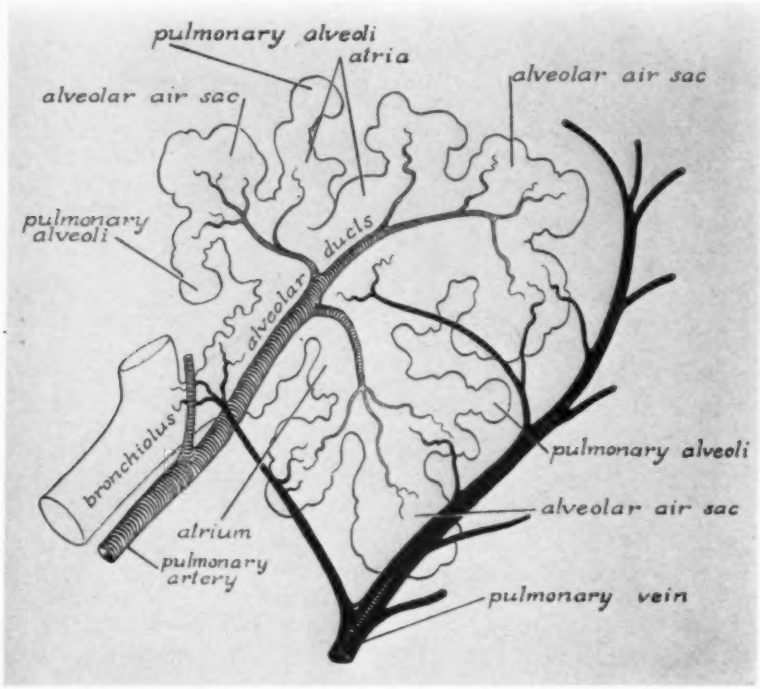

Fig. 4. Diagrammatic illustration of the microscopic anatomy of the respiratory bronchiole. After William Snow Miller.

embarrassment on the other might lead one to suspect hyaline membrane disease of the lung in the newborn.

This case is also of interest since it raises the suspicion that one or more factors in the maternal history may have produced this disease in the child: (1) Could the mother's limited cardiac reserve have produced the anoxia *in utero* which Tregillus believes is the primary causative agent? Contrary to Tregillus' postulate, however, oxygen administered immediately postnatally did not prevent the condition. (2) In view of penicillin and sulfa therapy during the pregnancy, the possibility of a miss from consideration those conditions in which the respiratory movements are absent or inadequate, since in the case of hyaline disease of the lung these are usually adequate, although they may sometimes be labored, with some tendency to retraction of the interspaces. Thus, we can disregard most intra-uterine asphyxias (prolonged labors, intra-uterine hemorrhage, detachment of the placenta, compression of the brain, etc.), and concentrate upon the extra-uterine group.

Congenital malformations such as tracheal and bronchial bands and stenoses will prevent the postnatal expansion of the in-

volved segments or lobes of the lung and roentgenographically this will have the appearance of atelectasis, corresponding in degree with the severity of respiratory embarrassment. No paradox in this regard should exist. In these conditions there is usually a compensatory emphysema of the uninvolved lung.

A somewhat similar appearance may be produced by congenital aplasias or hypoplasias of the lung. If the hypoplasia is not excessive, no respiratory embarrassment may ensue. Indeed, moderate hypoplasia is perfectly compatible with long life and may be an incidental finding in the adult (15).

In primary atelectasis of the newborn the radiograph will usually reveal massive atelectasis of a considerable portion of the lung, with a shift of the mediastinum, compensatory emphysema, or obstructive emphysema. Here the respiratory embarrassment parallels the amount of atelectasis or obstructive emphysema and the shift of the mediastinum, and thus again the paradox of little atelectasis and marked respiratory embarrassment would not be present.

Neonatal pneumothorax may be produced by laceration of the visceral pleura from forceful artificial respiration, and by emphysema caused by bronchial occlusion, perhaps associated with defects in the pleura. This condition should be readily recognized radiographically, in that the dilated pleural space casts a uniform shadow delineated by a pleural line and containing no parenchymal markings. The collapsed lung adjoins this shadow.

Neonatal or congenital pneumonia of intra-uterine origin perhaps offers the greatest difficulty in diagnosis, but when it is accompanied by elevated temperature and bronchial respiration its differentiation on clinical grounds would appear possible.

It is apparent from the preceding discussion that demonstration of good aeration of the lungs on the radiograph, paradoxically coupled with labored breathing and other clinical manifestations of asphyxia, as in hyaline disease, does not occur in asphyxia neonatorum due to other causes. We may thus be dealing with a rather accurate method of diagnosis of hyaline disease of the lung. Many more cases will have to be observed, however, before a conclusive statement may be made in this regard.

SUMMARY

A case of hyaline disease of the lung in a newborn infant is described, and the gross and microscopic pathology of the lungs is correlated with the radiographic appearance of the chest on serial studies immediately prior to death.

The clinical picture is that of asphyxia, and the gross morphology of the lung would suggest atelectasis. The radiograph, however, shows the lung fields to be unusually well aerated. This aeration is shown microscopically to be due to air in the terminal bronchioles and alveolar ducts, and not in the alveoli, which are collapsed. Moreover, a hyaline membrane over the terminal bronchioles and alveolar ducts probably prevents adequate interchange of gases.

This paradoxical demonstration of aeration on the radiograph in a newborn child under seventy-two hours of age may indicate hyaline disease of the lungs. To our knowledge this finding has not previously been described.

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SUMARIO

El Aspecto Radiográfico de la Hialinosis Pulmonar en el Recién Nacido. Presentación de Un Caso.

Descríbese un caso de afección hialina del pulmón en un recién nacido, en el que la histopatología macro y microscópica de los pulmones se correlacionaba con el aspecto radiográfico del tórax en los estudios seriados verificados inmediatamente antes de la muerte a la edad de treinta y dos horas.

El cuadro clínico era de asfixia y la morfología macroscópica del pulmón sugería atelectasia. Sin embargo, la radiografía reveló que los campos pulmonares estaban extraordinariamente bien aireados. Según se observó microscópicamente, esa aireación se debía al aire en los bronquiolos terminales y los conductos alveolares, y no en los alvéolos, que estaban aplastados. Además, en este estado, una membrana hialina sobre los bronquiolos terminales y los conductos alveolares impide probablemente el intercambio adecuado de gases.

Ese hallazgo paradójico de aireación en la radiografía en un recién nacido de menos de setenta y dos horas puede indicar degeneración hialina de los pulmones. En lo que sepan los AA., ese hallazgo no había sido descrito antes.

The Right Pericardial Fat Pad[1]

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IT IS GENERALLY recognized that on a chest roentgenogram the pericardial fat pad often produces a shadow at the left apical border of the heart (3). It was our good fortune to observe two interesting autopsies on extremely obese white males. Upon opening the thoracic cage it was noted that the pericardial fat was markedly increased (Fig. 1). More significant was an unusually thick pericardial fat pad which covered the anterior and right lateral surface of the right auricle and superior vena cava. The question then presented itself: Would this fat pad produce a shadow on a postero-anterior roentgenogram of the chest similar to the shadow seen at the left border of the heart? It may be recalled that on routine postero-anterior chest films of obese persons the mid portion of the mediastinum at times appears broadened. This is usually explained by the elevated diaphragm and the transverse position of the heart.

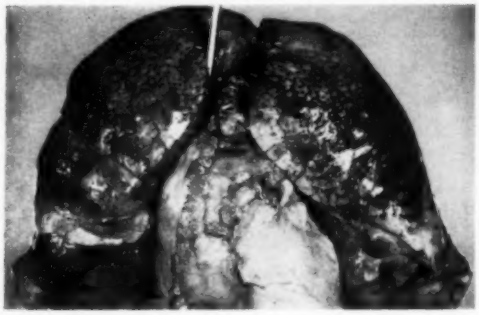

Fig. 1. Heart and lung *in situ*, with the prominent pericardial fat pad on the right.

It is the purpose of this paper to present findings in gross pathological specimen, and on x-ray films, to show (*a*) that there is a right pericardial fat pad at the level of right auricle and superior vena cava, (*b*) that this is possibly related to generalized obesity, and (*c*) that, when present, it can produce a shadow on the postero-anterior chest film. Our cases are of course far too few to be significant for statistical purposes.

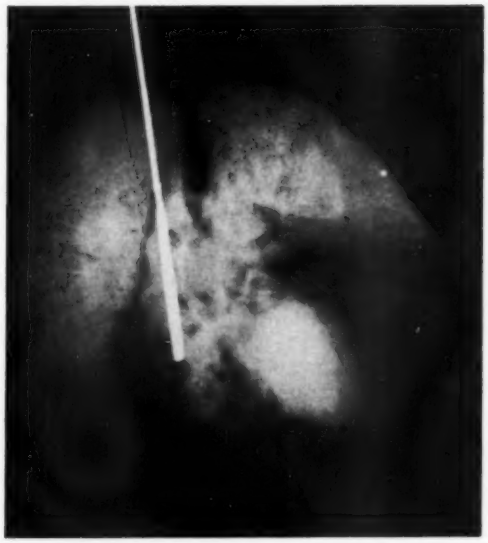

Fig. 2. Roentgenogram with a metallic knife in the superior vena cava, illustrating the shadow produced by a right pericardial fat pad.

CASE I (Figs. 1–4): A markedly obese white male died of cirrhosis of the liver. At autopsy a thick right pericardial fat pad was found.

CASE II: A markedly obese white male died of carcinoma of the stomach. At autopsy a right pericardial fat pad with the same anatomical relations as in the previous case was found.

It is realized that there is considerable distortion of the normal anatomy after death and particularly after autopsy. In order to prove that the fat pad seen on the right was not due to postmortem distortion but actually lay lateral to the superior vena cava, a finger was placed in

[1] From the Departments of Pathology and Radiology, Veterans Administration Hospital, Long Beach, Calif. Accepted for publication in May 1952.
Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director.

Fig. 3. Right pericardial fat pad dissected from auricle and superior vena cava. Also shown is the prominent left pericardial fat pad.

the superior vena cava and the thumb placed completely laterally. Approximately 1.5 cm. of pericardial fat was interposed between the fingers.

Roentgenograms of the specimen were taken (Fig. 2) with a metallic object completely filling the superior vena cava and extending into the right auricle. In these the right fat pad can be clearly seen. This fat was then dissected off the right auricle and superior vena cava and another picture was taken (Fig. 3) to show these relations more clearly.

It is felt that the knowledge that this structure is occasionally present may aid in explaining a prominence of the upper part of the cardiovascular shadow which otherwise might be interpreted as a dilated superior vena cava.

A search of the English literature reveals very little on the subject of pericardial fat pad. Hugo Roesler mentions its presence on the right side of the heart and the front of the aorta (1). Master related the left pericardial fat pad to obesity (2). Holt (3) describes discrete rounded densities seen on the postero-anterior roentgenogram in the right cardiophrenic angle due to right epipericardial fat. This, of course, is located at a considerably lower level than the fat pad which we have described.

Fig. 4. Antemortem chest roentgenogram, showing the broadened base of the heart.

CONCLUSION

In some obese patients, a right cardiac fat pad is present which we believe can produce a prominence of the upper half of the right border of the cardiovascular shadow as seen on a postero-anterior roentgenogram of the chest. Two such cases coming to autopsy are reported.

NOTE: We would like to express our gratitude to Dr. Frank Isaac, Chief, Radiological Service, to the Medical Illustration Department, and to the secretarial staff with whose help this paper was made possible.

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SUMARIO

El Paquete Adiposo del Lado Derecho del Pericardio

En algunos sujetos obesos, hállase presente un paquete de grasa en el lado derecho del pericardio, que, según se cree, puede producir una prominencia de la mitad superior del borde derecho de la sombra cardiovascular, al ser observado en una radiografía postero-anterior.

El conocimiento de que este tejido se halla presente de vez en cuando puede ayudar a interpretar una prominencia de la porción superior de la imagen cardiovascular que, de otro modo, podría tomarse por dilatacion de la vena cava superior.

Comunícanse 2 casos de este género en que se hizo la autopsia.

Chronic Arterial Occlusions of the Lower Extremities

An Arteriographic Study of 62 Cases[1]

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FOR MANY YEARS past arteriography has been an established procedure in the study of the circulation of the lower extremities. It has been frequently employed in Europe but its use in the United States has been exceptional and thus, if we exclude the initial works of Allen and others (1) and the later publications of Smith and Campbell (2, 3), the reports on this method have been few and isolated. With the improvement of radiopaque substances and the progress of the technic of roentgenography, this method of exploration has attained a high level of perfection. Leriche (4), dos Santos (5), Reboul (6), Lindbom (7) and others (8, 9) have indicated its advantages in the study of alterations in the circulation of the extremities.

One of the reasons adduced for not utilizing arteriography is that it does not furnish any data that cannot be obtained by simpler methods involving less danger to the patient. Our experience is not in accord with this view. In support of our position we present an analysis of 62 arteriograms obtained in cases in which one of the arteries of the lower extremities was occluded in order to determine the possible advantages of the procedure.

MATERIAL AND METHODS

During the last two years arteriography has been carried out in the majority of patients entering the Department of Vascular Diseases at the Havana University Hospital. For the purposes of this article we have selected only those cases with the following characteristics: (1) occlusion of one of the principal arteries of the lower extremities; (2) arteriograms sufficiently clear to allow a detailed study of the arteries of the leg and thigh; (3) an etiological diagnosis either clinically evident or shown by histologic examination of the arteries in doubtful cases; (4) knowledge of the subsequent course of the patient's illness.

After this selection, it was possible to separate 62 arteriograms from a total of 123. All the patients underwent the same general methods of treatment, and none showed symptoms of acute arterial occlusion, since in such circumstances we do not utilize arteriography, as we consider it harmful.

Technic: The puncture of the femoral artery was made at the level of the crural arch, with a No. 18 needle. When the femoral pulse is not felt, it is because the occlusion is higher, at the level of the iliac or the aorta, and an aortogram is necessary to visualize the occluded segment. No special care was taken to direct the point of the needle upward or downward, no case having been encountered in which the puncture has been made over the deep femoral artery, as has been mentioned by some (7).

The radiopaque substance utilized was Diodrast. In the first cases a 70 per cent solution was employed, but later solutions of 50 or 35 per cent were used. Between 30 and 50 c.c. was injected by means of an apparatus under positive pressure of 30 pounds per square inch, the injection being completed in five or six seconds. The utilization of the injecting apparatus is very important for obtaining good arteriograms, since, in addition to allowing the constant and uniform entry of the Dio-

[1] This work has been carried out in co-operation with the Professors of Radiology and Physiotherapy, J. M. Viamonte, M.D., and Hernandez Beguerie, M.D., and with the Professors of Surgery, E. R. de Aragon, M.D., and R. Guerra, M.D., of the University of Havana School of Medicine, Havana, Cuba.

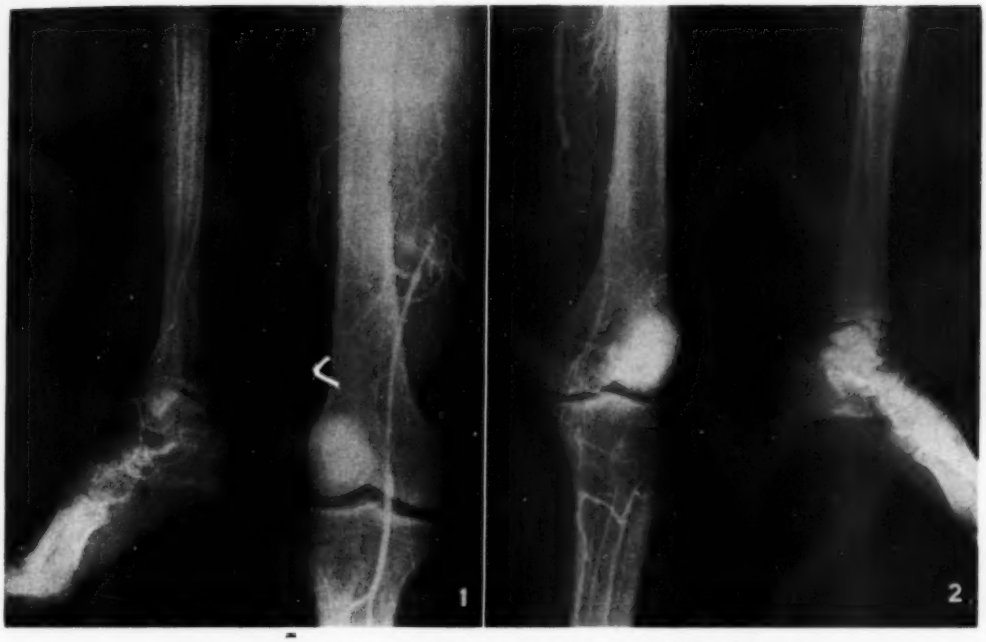

Fig. 1. Obstruction of Femoral Artery in Thromboangiitis Obliterans.

Case 3: D. C., 37 years, male. Marked thinning of the femoral artery which terminates in obstruction of the upper third. Extensive collateral circulation which restores the femoral in its lower third. Diminished caliber of the popliteal artery. Obstruction of the anterior tibial at its termination but with good circulation of the foot. The posterior tibial is not visualized and a great dilatation of the peroneal artery is observable.

This case shows the typical arterial lesions of thromboangiitis obliterans and at the same time demonstrates a good collateral circulation.

Fig. 2. Obstruction of Femoral Artery in Arteriosclerosis Obliterans.

Case 14: J. B., 63 years, male. Obstruction of the femoral artery in its middle third, giving rise to an extensive collateral circulation which only partially restores the circulation of the anterior tibial. This becomes obstructed again, and the lower third of the leg shows a marked decrease of circulation.

In the femoral artery, notches and dilatations characteristic of arteriosclerosis obliterans are observable.

This case typifies an obstruction of the femoral with good adjacent collateral circulation which, however, did not succeed in restoring the circulation of the leg. The prognosis is poor, and the patient eventually underwent amputation.

drast, it prevents displacement of the needle, which is one of the causes of extravasation when the injection is performed by hand.

A previous test of sensitivity to Diodrast was always carried out by means of an intravenous injection of 5 c.c. Where symptoms of intolerance appeared during the following twenty minutes, arteriography was not undertaken.

Although local anesthesia with novocain was used in some cases for the arterial puncture, in the majority Pentothal was used, which has the advantages of making the examination painless and allowing an easier manipulation of the patient.

A focus-plate distance of 72 inches was maintained, so that by placing two films below the lower extremity, the visualization of the arteries of the thigh and leg could be obtained with a single exposure. The exposure should be made from three to five seconds after completing the injection, for visualization of the entire arterial tree of the affected member.

In no case did a serious complication occur, although on a few occasions small hematomas, which rapidly disappeared, were produced at the level of the punctured artery. On only two occasions was the injection made outside of the artery, causing some discomfort which was eliminated by analgesics, without further sequelae.

TABLE I: OCCLUSIONS OF THE ARTERIES OF THE LEG*

Case	Etiology	Age (years)	Anterior Tibial	Posterior Tibial	Peroneal	Collateral Circulation	Course
1	A.O.	49	Ocl.	Perm.	Perm.	Good	Favorable
2	A.O.	60	Ocl.	Perm.	Perm.	?	Favorable
3	T.O.	40	Ocl.	Ocl.	Perm.	Good	Favorable
4	T.O.	45	Ocl.	Ocl.	Perm.	Good	Favorable
5	T.O.	33	Ocl.	Perm.	Perm.	?	Favorable
6	A.O.	60	Ocl.	Ocl.	Perm.	Bad	Amputation
7	A.O.	56	Perm.	Ocl.	Perm.	Normal	Favorable
8	T.O.	37	Ocl.	Ocl.	Perm.	Fair	Favorable
9	T.O.	48	Ocl.	Ocl.	Perm.	Fair	Favorable
10	A.O.	55	Ocl.	Ocl.	Ocl.	Bad	Amputation
11	T.O.	34	Ocl.	Perm.	Perm.	Good	Favorable
12	T.O.	32	Ocl.	Ocl.	Ocl.	Bad	Amputation
13	A.O.	56	Perm.	Ocl.	Perm.	Good	Favorable
14	A.O.	59	Perm.	Ocl.	Ocl.	Good	Favorable
15	A.O.	60	Ocl.	Ocl.	Ocl.	Good	Favorable
16	A.O.	63	Ocl.	Ocl.	Perm.	Good	Favorable
17	T.O.	40	Ocl.	Ocl.	Perm.	Good	Favorable
18	A.O.	53	Ocl.	Ocl.	Perm.	Good	Favorable
19	A.O.	55	Perm.	Ocl.	Perm.	Good	Favorable
20	T.O.	30	Perm.	Ocl.	Ocl.	Good	Favorable
21	A.O.	65	Ocl.	Ocl.	Perm.	Good	Favorable
22	T.O.	48	Ocl.	Ocl.	Ocl.	Good	Favorable
23	A.O.	52	Perm.	Ocl.	Ocl.	Normal	Favorable
24	A.O.	52	Ocl.	Perm.	Perm.	Good	Favorable
25	T.O.	39	Ocl.	Perm.	Perm.	Good	Favorable
26	A.O.	74	Ocl.	Ocl.	Perm.	Absent	Amputation
27	A.O.	46	Perm.	Ocl.	Ocl.	Good	Favorable
28	A.O.	64	Ocl.	Ocl.	Perm.	Good	Favorable
29	T.O.	39	Ocl.	Ocl.	Ocl.	Good	Favorable

* Ocl.: Occluded. Perm.: Permeable. T.O.: Thromboangiitis obliterans. A.O.: Arteriosclerosis obliterans.

TABLE II: OCCLUSIONS OF THE POPLITEAL ARTERIES*

Case	Etiology	Age (years)	Extension	Restoration of Main Circulation	Collateral Circulation	Course
1	A.O.	59	Total	P.T., A.T., P.	Good	Cured
2	A.O.	60	Total	P.T., A.T., P.	Good	Cured
3	A.O.	72	Total	None	Bad	Amputated
4	A.O.	69	Total	P.T.	Good	Cured
5	A.O.	62	Total	None	Bad	Amputated
6	Primary thrombosis	40	Total	P.T.	Good	Cured
7	T.O.	47	Total	P.T. and P	Good	Cured
8	T.O.	19	Total	None	Bad	Amputated

* T.O. Thromboangiitis obliterans. A.O. Arteriosclerosis obliterans. P.T. Posterior tibial. A.T. Anterior tibial. P. Peroneal.

RESULTS

Localization: In the 62 cases studied, the distribution of the occluded arteries was as follows: femoral 25, popliteal 8, and leg arteries 29. Of the arteries of the leg, the anterior tibial was occluded in 22 cases, the posterior tibial in 23, and the peroneal in 9.

The most frequent level of occlusion for the femoral artery was at its origin immediately below the deep femoral. There were 16 such cases, and in 12 of these there was no visualization of the femoral along its entire course, while in 2 the arterial lumen was restored at the level of its lower third segment. In the remaining 9 cases, the occlusion was located in the lower third of the artery in 7, and in only 2 cases in the middle third.

The popliteal artery was occluded in its middle portion, at the level of the interarticular space in 5 cases; in the 3 remaining, the occlusion of the artery was higher, at the level of its origin.

In the leg, in 9 cases a single artery was occluded; this was always one of the tib-

TABLE III: OCCLUSIONS OF THE FEMORAL ARTERIES*

Case	Etiology	Age (years)	Level	Extension	Restoration of Main Circulation	Course
1	A.O.	67	Origin	Total	P., P.T.	Amputation
2	T.O.	24	Lower third	10 cms.	P., A.T.	Favorable
3	T.O.	37	Origin	Middle third	F., P., p., A.T.	Favorable
4	A.O.	66	Origin	Total	None ?	Favorable
5	T.O.	44	Origin	Total	None	Amputation
6	A.O.	40	Origin	Total	P. and P.T.	Favorable
7	A.O.	52	Origin	Total	P., p., P.T., A.T.	Favorable
8	A.O.	70	Origin	Sup. two thirds	P., p., P.T., A.T.	Favorable
9	A.O.	68	Origin	Total	None	Amputation
10	A.O.	60	Origin	Total	P., p., P.T., A.T.	Amputation
11	Primary thrombosis	42	Lower third	Lower third	P.T., A.T., p.	Favorable
12	A.O.	67	Middle third	Lower two thirds	P.T. and A.T.	Favorable
13	A.O.	62	Origin	Sup. two thirds	P. and P.T.	Favorable
14	A.O.	63	Middle third	Lower third	A.T. Reobstructed	Amputation
15	A.O.	65	Origin	Total	P., A.T., P.T.	Favorable
16	A.O.	59	Origin	Sup. two thirds	P., p., A.T., P.T.	Favorable
17	T.O.	38	Origin	Total	Partial	Favorable
18	A.O.	66	Origin	Total	P.T., A.T., p.	Favorable
19	A.O.	58	Origin	Total	P., p., A.T., P.T.	Favorable
20	T.O.	40	Lower third	Lower third	P.T. and p.	Favorable
21	A.O.	61	Middle third	Lower two thirds	None	Amputation
22	A.O.	54	Origin	Total	A.T.	Amputation
23	A.O.	62	Lower third	Lower third	P., p., A.T., P.T.	Favorable
24	A.O.	72	Middle third	Inf. two thirds	None	Amputation
25	A.O.	59	Sup. third	Middle third	F., P., P.T., p.	Favorable

* A.O. Arteriosclerosis obliterans. T.O. Thromboangiitis obliterans. P. Popliteal. p. Peroneal. F. Femoral. P.T. Posterior Tibial. A.T. Anterior Tibial.

ial arteries, in the proportion of 6 in the anterior and 3 in the posterior. In 5 cases the three arteries were obstructed, while in 14 two were occluded, the two tibial arteries in 10 patients and the posterior tibial with the peroneal in 4 cases. In no case was the peroneal artery obstructed alone or in combination with the anterior tibial.

Etiology: The etiology of the 62 cases according to the arterial segment occluded is shown in Tables I, II, and III. The fact that thromboangiitis obliterans affected the femoral in 5 cases and the popliteal in 2, out of a total of 19 patients, is important, proving as it does that, contrary to the usual belief, the occlusion of the arteries of the thigh and the ankle in this illness is not rare. The cases of arteriosclerosis were more proportionally distributed since, in a total of 41 cases, the femoral was occluded in 19, the popliteal in 5, and the leg arteries in 17.

In the 41 cases of arteriosclerosis there could be observed isolated or combined thickening of the intima, ampullar dilatations, or calcifications, which facilitated the diagnosis. Of the 19 cases of thromboangiitis, in 3 there were some accompanying arteriosclerotic changes; in 2 no alterations of the lumen or arterial contour were observed above or below the occlusion, while in the other 14 cases arterial changes were observed, consisting in narrowing of the vessel up to actual occlusion or at times diminished caliber of segments of the arterial lumen, which is characteristic of this condition. In the two cases of primary thrombosis studied, no alteration of the contour or lumen of the arteries could be shown.

Prognostic Value: Since arteriography allows the direct study of circulatory alterations of an extremity by indicating the level of the arterial occlusion, the state of the collateral circulation, the length of the arterial segment occluded, and the etiologic diagnosis, we believe that it offers a better possibility than any other method of arriving at a prognosis in each case.

On analyzing the course of the 62 cases forming the subject of this work and the data obtained by the arteriographic ex-

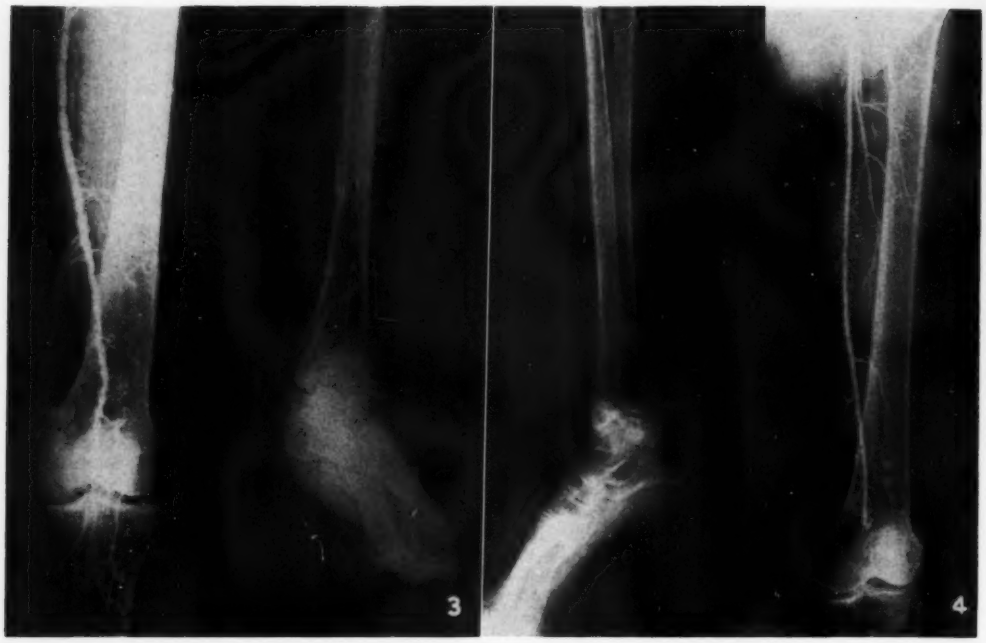

Fig. 3. Obstruction of Popliteal Artery in Arteriosclerosis Obliterans.

Case 2: J. I., 60 years, male. Typical arteriosclerotic changes in the femoral artery, causing an extensive collateral circulation which partially restores the circulation of the peroneal and anterior tibial which, however, affected by arteriosclerosis obliterans, became obstructed again. The circulation of the leg is maintained by an extensive collateral circulation.

This patient progressed favorably after amputation of two toes.

Fig. 4. Obstruction of Popliteal Artery in Arteriosclerosis Obliterans.

Case 5: C. G., 68 years, female. Numerous notches along the femoral artery accompanied by marked thickening of the intima (typical lesions of arteriosclerosis obliterans). Obstruction of the popliteal at its origin, with scant collateral circulation and with none of the leg arteries visualized.

This patient underwent amputation at the level of the lower third of the thigh. The anatomical findings coincided with the findings in the arteriogram.

amination, a close relation was found which, in the majority of cases, enabled a prognosis to be made for each patient.

In 8 of the 25 femoral obstructions amputation of the extremity above the knee was necessary, there being found in every case an extensive occlusion of the femoral from its origin, without restoration of the main arterial circulation at the level of the thigh, knee, or leg at any time. In contrast, in the cases in which the course was favorable, there was always a partial thrombosis of the femoral, the popliteal had become opaque, and two or three of the principal arteries of the leg were permeable. It is interesting to note the fact that of the 8 patients requiring amputation, 7 had arteriosclerosis and only 1 thromboangiitis obliterans.

The 3 occlusions of the popliteal artery requiring a major amputation presented the same alterations of total absence of visualization of the principal vessels of the leg and very slight collateral circulation. One was a case of thromboangiitis obliterans and the other 2 of arteriosclerosis. In the cases with a favorable evolution, two or more arteries of the leg were visualized.

In the 29 occlusions of the leg arteries, on only 4 occasions was it necessary to amputate the affected extremity, in 3 cases of arteriosclerosis and 1 of thromboangiitis obliterans. In 2 of the cases in which amputation was done the three arteries of the leg were occluded; in the other 2 both tibial arteries. Common to the 4 was the almost total absence of collateral circula-

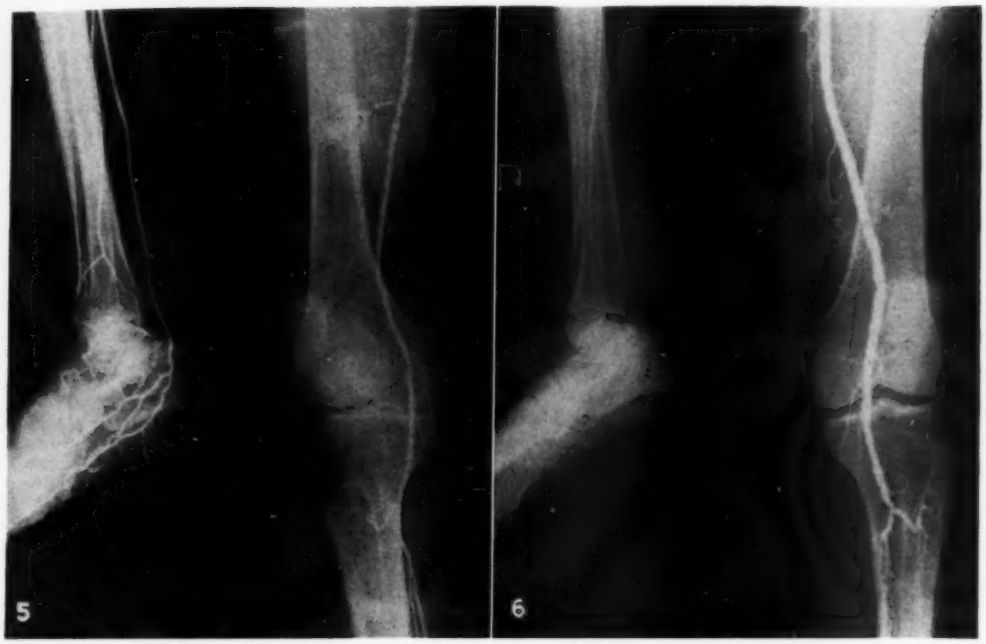

Fig. 5. Obstruction of Leg Arteries in Arteriosclerosis Obliterans.

Case 1: P. L., 49 years, male. Typical lesions of arteriosclerosis obliterans in the femoral and popliteal arteries. The anterior tibial is not visualized. The circulation of the leg and foot is maintained by the posterior tibial and the peroneal. The progress of the patient was favorable, confirming the arteriographic findings.

Fig. 6. Obstruction of Leg Arteries in Arteriosclerosis Obliterans.

Case 26: M. V., 74 years, male. Numerous thickenings of the intima along the femoral and popliteal arteries which do not diminish the caliber of the lumen and which are characteristic of arteriosclerosis obliterans. Occlusion of the anterior and posterior tibial. The peroneal is the only permeable artery in the leg. The collateral circulation is insufficient.

The arteriogram of this patient typifies a case with insufficient collateral circulation of the leg with an unfavorable prognosis. Amputation was performed two weeks later.

tion, the opaque substance remaining in the leg without reaching the foot. In the cases with a favorable course, although one or various arteries were occluded, arteriography demonstrated the existence of an extensive collateral circulation, which through the dorsal and plantar circulation completed the irrigation of the foot.

SUMMARY

1. The technic of arteriography in the lower extremities has been described, and the low incidence of complications has been noted.

2. The results obtained in 62 cases of chronic occlusions of the principal arteries of the lower extremities have been analyzed.

3. Attention has been drawn to the importance of the localization of the occlusion, the state of the collateral circulation, and the restoration of the main circulation in the prognosis of these cases.

4. Arteriography is recommended as the method which by itself offers the most information in cases of arterial occlusion by allowing a direct study of the circulatory alteration of a lower extremity.

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Fig. 7. Obstruction of Leg Arteries in Thromboangiitis Obliterans.

Case 29: C. G., 39 years, male. Moderate narrowing of the femoral artery in its middle third, which suggests the possibility of a thromboangiitis obliterans. Obstruction of the posterior tibial and peroneal arteries at their origin. Obstruction of the anterior tibial in its middle third. Extensive collateral circulation of the leg, which allows a good circulation in the foot.

As shown in the arteriogram, the good compensatory circulation presages a favorable development.

SUMARIO

Las Oclusiones Arteriales Crónicas de los Miembros Inferiores: Estudio Arteriográfico de 62 Casos

A fin de determinar las ventajas de la arteriografía para el estudio de la circulación de los miembros inferiores, analizáronse 62 arteriogramas obtenidos en casos de oclusión arterial. La arteria femoral estaba ocluída en 25 casos, la poplítea en 8 y las arterias de la pierna en 29 (tibial anterior en 22; tibial posterior en 23; peronea en 9). En 41 casos, la oclusión tenía por causa arteriosclerosis; en 19 tromboangiítis obliterante; y en 2 trombosis primaria.

Como la arteriografía indica el nivel de la oclusión arterial, el estado de la circulación colateral, la longitud del segmento arterial ocluído y el diagnóstico etiológico, ofrece más posibilidades de llegar a un pronóstico, que ningún otro método de estudio. En la serie presentada ahora, resultó ser sumamente fidedigna en ese sentido.

Descríbese la técnica del procedimiento. En ningún caso se observó la menor complicación grave.

Clinical Evaluation of a Concentrated Iodine Preparation[1]

For Intravenous Nephrography and Pyelography

A. WAITE BOHNE, M.D., and WM. W. CHRISTESON, M.D.

IN RESPONSE to the increasing interest in more concentrated radiographic media for intravenous pyelography and nephrography, clinical evaluation of 70 per cent Urokon Sodium (sodium acetrizoate)[2] has been made. The methods used in the evaluation were (1) intravenous nephrography, and (2) intravenous pyelography.

INTRAVENOUS NEPHROGRAPHY

Thirteen nephrograms were made on adult patients, with the technic of Wall and Rose. Briefly this procedure consists of preparation of the patient as if for intravenous pyelography; exposure of a preliminary film; intravenous injection of 50 c.c. of 70 per cent Urokon Sodium as rapidly as possible (five seconds) through a 15-gauge needle; exposure of the first film at ten seconds and the second film at twenty-five seconds following the end of the injection; completing the excretory urogram series with exposure of films at five, ten, and fifteen minutes. Thus, all three phases of the cycle of events associated with nephrography, as outlined by Vesey *et al.*, are covered. These are the *arterial phase*, during which the contrast medium fills the aorta, renal, and associated vessels; the *capillary phase*, during which the medium fills the arterioles and venules and gives the kidney maximum radiopacification; the *excretory phase*, in which the tubules and collecting system are filled to give "intravenous pyelograms."

No special x-ray or other equipment or extra personnel was required. Due to human error, our first films were taken at five to fifteen seconds following completion of the injection, and our second films at twenty-two to thirty seconds.

Reactions: Of the 13 patients, 10 suffered reactions to the solution. Eight of them had mild transient nausea, choking, and flushing, lasting two to ten minutes. In one case these symptoms were followed by generalized urticaria which responded quickly to antihistaminics, but the patient continued to complain of generalized malaise for thirty-six hours. In another patient extravasation of the dye resulted in tissue slough requiring skin graft.

Results: Ten good nephrograms (capillary phase) were obtained (Figs. 1 and 2), 2 were poor, and there was 1 failure. In 6 cases both the first and second films showed the nephrogram; in 10 it was present in the second film.

Six of the total series were studied for kidney tumor. There was pooling or puddling of dye in 4 of these, 3 of which were proved at surgery to be hypernephromas. The other did not come to surgery. Another showed a non-opaque shadow in the right kidney (Fig. 1) proved at surgery to be a benign intrarenal cyst.

Eight arteriograms (arterial phase) were obtained, all but one occurring in the first film. In only 4 of these were the renal vessels visualized with any degree of accuracy.

Figure 3 represents an arteriogram visualizing the aorta, both renal vessels, the hepatic, splenic, thoracic, intercostal, colic, and iliac vessels.

Because satisfactory pyelograms were available prior to nephrography in 3 cases, the excretory phase was studied in only 10 of this series. These films were found to be conclusive in 6 cases, whereas 4 cases required further study, such as retrograde pyelography or laparotomy, to arrive at a definite diagnosis. Of the 4 patients requiring further study, 3 had markedly diminished function of the affected kidney,

[1] From the Division of Urology, Department of Surgery, The Henry Ford Hospital, Detroit, Mich. Accepted for publication in May 1952.

[2] Generously supplied by the Mallinckrodt Chemical Works of St. Louis, Mo.

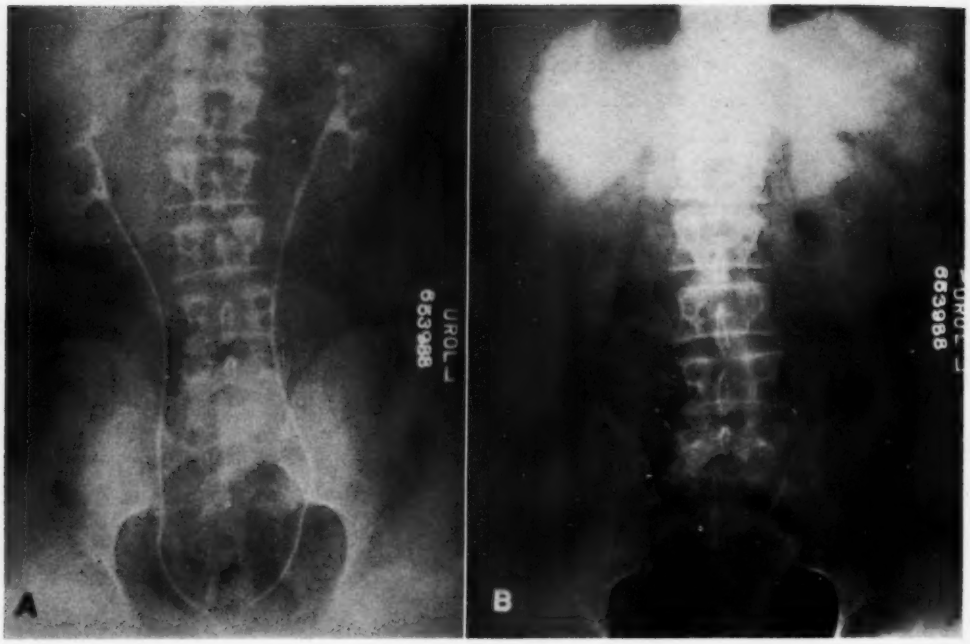

Fig. 1. A. Retrograde pyelogram showing space-occupying lesion in right kidney.
B. Intravenous nephrogram showing non-opaque area corresponding to space-occupying lesion in the retrograde pyelogram, later found to be a benign cyst.

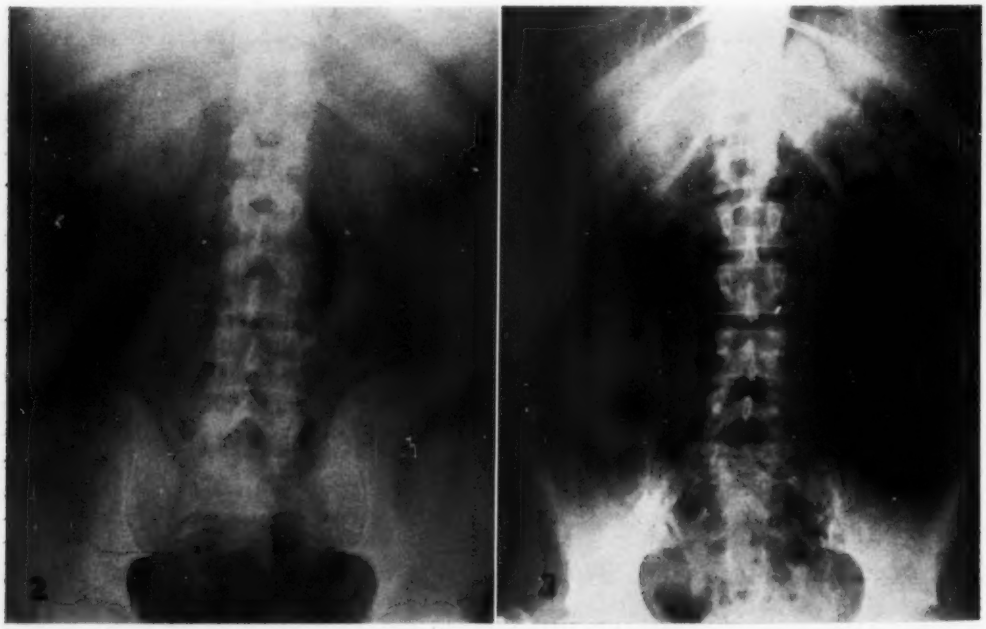

Fig. 2. Capillary phase, or "nephrogram."
Fig. 3. Arterial phase of intravenous nephrogram using 70 per cent Urokon Sodium.

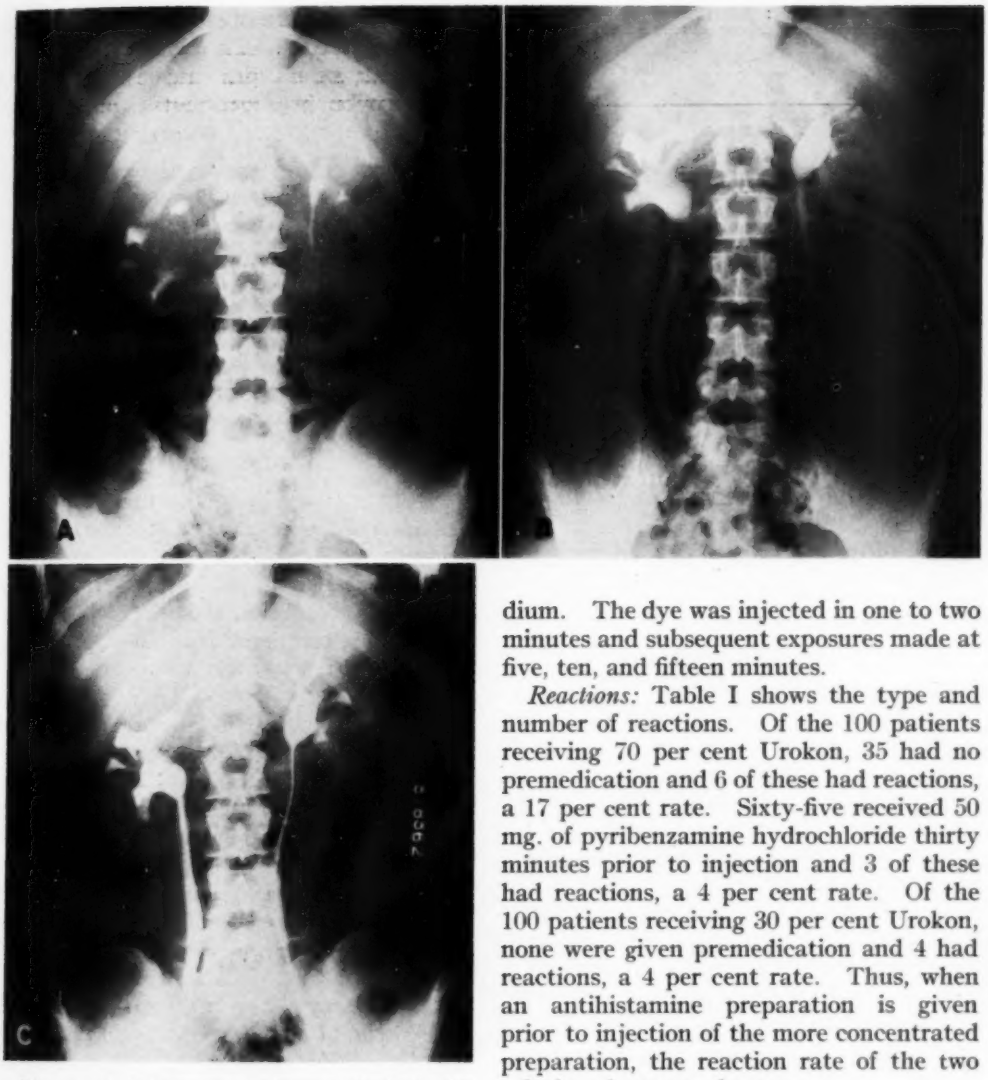

Fig. 4. A. Intravenous pyelogram obtained with 30 per cent Urokon Sodium. B. Intravenous pyelogram obtained with 70 per cent Urokon Sodium. C. Retrograde pyelogram obtained with 15 per cent Skiodan.

thus accounting for the poor visualization.

INTRAVENOUS PYELOGRAPHY

For evaluating 70 per cent Urokon Sodium by intravenous pyelography 100 adult patients were given 25 c.c. of 70 per cent Urokon Sodium and 100 adult patients received 25 c.c. of 30 per cent Urokon Sodium. The dye was injected in one to two minutes and subsequent exposures made at five, ten, and fifteen minutes.

Reactions: Table I shows the type and number of reactions. Of the 100 patients receiving 70 per cent Urokon, 35 had no premedication and 6 of these had reactions, a 17 per cent rate. Sixty-five received 50 mg. of pyribenzamine hydrochloride thirty minutes prior to injection and 3 of these had reactions, a 4 per cent rate. Of the 100 patients receiving 30 per cent Urokon, none were given premedication and 4 had reactions, a 4 per cent rate. Thus, when an antihistamine preparation is given prior to injection of the more concentrated preparation, the reaction rate of the two solutions becomes the same.

No reaction was of long duration and all responded to antihistaminics and/or epinephrine injection.

Results: The results of this series are shown in Table II. The interpretation represents the consensus of the Urology Staff.

A comparison of the films obtained with 30 per cent and 70 per cent Urokon Sodium and retrograde pyelograms (15 per cent Skiodan) on the same patient is presented in Fig. 4. The 70 per cent film

TABLE I: REACTIONS

Reaction	Urokon Sodium 70%	Urokon Sodium 30%
Transient nausea	2	1
Transient flushing	3	2
Urticaria	3	2
Arm pain	3	0
Palpitation	1	0
Reactions without antihistamine	6 (17%)	4 (4%)
Reactions with antihistamine	3 (4%)	
Total with reactions	9	4

(Fig. 4B) closely approaches the quality of retrograde pyelograms. The clearness of outline, promptness and degree of filling of the pelves, as well as the filling of the ureters, seem to be much better with the 70 per cent dye. These features and the fact that the best delineation often appeared in the five-minute film suggest that the T_m of the various iodides has not been realized by using less concentrated preparations.

CONCLUSIONS

Seventy per cent Urokon Sodium has been found to meet satisfactorily most requirements for radiographic media in intravenous nephrography.

This series of nephrograms is too small to be conclusive, but it does suggest that intravenous nephrography may be a valuable aid in (1) differentiating renal and extrarenal undiagnosed masses; (2) differentiating renal tumors and cysts; (3) estimation of blood flow to renal tissue; (4) estimation of a functioning tubular mass. The procedure is not reliable for visualization of renal vessels and should not be substituted for translumbar arteriography. On the other hand, it gives considerable information other than vessel visualization and eliminates most of the disadvantages of arteriography.

The use of Urokon Sodium for routine intravenous pyelography is highly recommended. The films closely approach the clearness of retrograde pyelograms in most instances, often making the latter unnecessary.

Reactions with the 70 per cent preparation are somewhat more frequent than with the weaker media. These reactions, however, are transient and can be reduced in number by premedication with antihistaminics to equal those occurring with the less concentrated media.

TABLE II: COMPARISON OF PYELOGRAMS WITH 70% AND 30% UROKON SODIUM

Result	Urokon Sodium 70%	Urokon Sodium 30%
Good pyelograms	69	33
Fair pyelograms	24	52
Poor pyelograms	7	15
TOTAL	100	100

SUMMARY

In order to evaluate the use of 70 per cent Urokon Sodium for intravenous nephrography and pyelography, this medium was used for a series of 13 nephrograms and for 100 pyelographic studies. The pyelograms were compared with an equal number obtained with 30 per cent Urokon Sodium.

This concentrated iodine preparation is an excellent medium for nephrography and is superior to the 30 per cent preparation in intravenous pyelography, in many instances eliminating the need for retrograde pyelograms.

Intravenous nephrography is quite useful in opacifying renal and extrinsic masses and in estimating a functioning tubular mass. Excellent visualization of the collecting system is also possible. Nephrography should not be used in place of translumbar arteriography.

Allergic reactions to this concentrated iodide may be kept to a minimum by the prophylactic administration of antihistaminic preparations.

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SUMARIO

Justipreciación Clínica de una Preparación Concentrada de Yodo

A fin de justipreciar el uso del Urokón Sódico al 70 por ciento para la nefrografía y la pielografía intravenosas, se empleó dicho medio en una serie de 13 nefrogramas y en 100 estudios pielográficos. Los pielogramas fueron comparados con un número igual, obtenidos con Urokón al 30 por ciento.

Obtuviéronse 10 buenos nefrogramas y se deduce que esa preparación concentrada de yodo constituye un medio excelente para el procedimiento. La serie indica que la nefrografía intravenosa es útil para las tumefacciones renales y extrínsecas opacifacientes y para apreciar una tumefacción tubular funcional. También es posible obtener excelente visualización del aparato colector, pero el procedimiento no es fidedigno para el descubrimiento de los vasos renales y no debe usarse en lugar de la arteriografía.

Los pielogramas obtenidos con la solución más concentrada (70 por ciento) de Urokón Sódico fueron superiores a los tomados con la solución al 30 por ciento y en calidad se aproximaron mucho a los pielogramas retrógrados, eliminando en muchos casos la necesidad de los últimos.

Hubo algunas reacciones a ese yoduro concentrado, pero pueden reducirse a un mínimo con el empleo profiláctico de antihistamínicos.

The Osseous Radiographic Findings of Chronic Renal Insufficiency[1]

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CHRONIC RENAL insufficiency is capable of producing marked changes in the roentgen appearance of the osseous system, varying both in degree and type. The object of the present paper is to review briefly such changes and to present a rather unusual manifestation of chronic renal insufficiency, namely, predominance of an osteosclerotic reaction.

Much has been written in the past on so-called "renal rickets" with its rather characteristic changes (3, 9, 13, 14, 18, 23, 24). The adult counterpart of this condition, with osteoporosis of the skeleton with or without metastatic soft-tissue calcifications, has also been frequently described (1, 2, 4, 6, 7, 8, 11, 12, 15, 16, 19, 25). Very little mention has been made, however, of the occurrence of osteosclerosis in renal insufficiency (7, 8, 25).

ETIOLOGY

Rule and Grollman (19) gave an acceptable classification of the various etiologic factors of osteonephropathy as follows:

A. Primary Urinary Tract Disturbances
   1. Chronic glomerulonephritis; pyelonephritis; nephrosis.
   2. Congenital malformations: polycystic kidneys; renal hypogenesis.
   3. Urinary tract obstruction with secondary renal lesions: urethral valves; prostatic enlargement; calculi; urethral, bladder neck, or ureteral strictures; hydroureter.
   4. Primary tubular functional changes which may or may not show anatomical changes.
      (*a*) Hypochloremic - glycosuric type (deToni-Fanconi syndrome)
      (*b*) Hypochloremic type without glycosuria

B. Primary Extrarenal Disturbances
   1. Endocrine disease: hyperparathyroidism
   2. Metabolic disturbances: cystine storage disease

PATHOLOGICAL CHANGES

Jaffe and Ginzler (8) in 1941 presented a series of 12 cases of renal insufficiency in adults, describing the pathological changes in the bones and giving the theories as to their modus operandi. In the slightly advanced cases the findings were restricted to the spongy trabeculae, particularly those of the vertebrae. Scattered Howship's lacunae, usually filled with connective-tissue cells and multinucleated osteoclasts, were observed along the trabecular surfaces. Occasional evidence of osteoblastic repair in an erosion space might be seen, but no significant new-bone formation was found. The more advanced stage was described as showing, in addition, encirclement and perforation of the trabeculae by tracts of connective tissue. There were enlargement and erosion of the haversian canals of the cortex along with concomitant reparative changes in the form of new-bone apposition to the trabeculae. The over-all picture still tended toward osteoporosis, since the reparative process was slight. Advanced osseous changes were noted when the renal insufficiency was protracted and had fluctuated in intensity. The spongy bone

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architecture was grossly altered, with close-meshed spongiosa and thickened, distorted trabeculae. The over-all picture is then one of osteosclerosis. Microscopically, this seems to have developed through the gradual accretion of new bone, with the reparative process predominating over resorptive changes. "Renal osteosclerosis" was present in 3 of Jaffe and Ginzler's cases.

In classical renal rickets, the parathyroid glands usually undergo secondary hyperplasia (5, 17, 24). Gross or microscopic evidence of such a change was present in 11 of the 12 cases of Jaffe and Ginzler. One case showed no parathyroid hyperplasia, although the bone changes were moderately advanced.

Rutishauser (20–22) concluded, after considerable animal experimentation, that the acidosis accompanying chronic renal insufficiency may be the more important factor in producing the bone changes, and Jaffe and Ginzler are in agreement with this opinion. They do not believe that the parathyroid hyperplasia explains the total pathological picture, especially the osteosclerosis, which is not usually seen in association with hyperparathyroidism. Jaffe, Bodansky, and Chandler (10) produced generalized osteoporosis and "osteitis fibrosa" in animals similar to that seen in renal insufficiency, by the use of ammonium chloride and varying amounts of calcium in the diet, thus lending weight to the belief of Rutishauser that the accompanying acidosis is implicated in the production of bone changes.

In renal insufficiency, there are retention of nitrogenous products with an elevated non-protein-nitrogen level, retention of phosphorus with an elevated serum phosphorus, and a tendency toward a low serum calcium. Because of decreased ability of the kidney to form base, the body is forced to excrete fixed base such as bone calcium and magnesium in order to eliminate the acid end-products of metabolism. This drainage of body calcium secondary to systemic acidosis indirectly tends to produce osteoporosis. In addition, there is excretion into the intestinal tract of excess phosphates, which tend to unite with the dietary calcium and thus prevent its intestinal absorption. With periods of fluctuation in the renal insufficiency and the accompanying acidosis, repair takes place in the way of new-bone formation. If this new-bone deposition predominates over the process of resorption, there can result an over-all osteosclerosis, as in the case to be reported.

ROENTGEN FINDINGS

Sussman and Poppel (25) have summarized nicely the radiographic changes in so-called "renal osteitis", as follows:

I. Osseous Changes
   A. Before epiphyseal closure

      Group 1: The typical changes occur in the extremities of the diaphyses of the long bones, especially in the distal ends of the radii and ulnae, where the metaphyses are thickened, cupped, and have irregular fluffy margins. The metacarpal and phalangeal metaphyses reveal similar appearances. Following normal stresses and strains, the epiphyses may be displaced. The skull shows little change.

      Group 2: This group is associated with a much more severe type of renal damage. The bones show general osteoporosis and an obliteration of all compact tissue. The cortical bone of the phalanages and metacarpals appears more rarefied than the cancellous bone, which reveals a closer reticulation than normal. The ends of the diaphyses are deeply cupped, the cupped extremities having a ground-glass appearance. The skull is thickened and shows a granular decalcification.

   B. After epiphyseal closure
      1. General decalcification.
      2. Cortical thinning and disintegration, especially in the phalanges and the long bones.
      3. *Osteosclerosis.* This may be

Fig. 1. Thoracic spine showing diffuse osteosclerotic changes.

seen in the more protracted cases and may appear as dense sclerosis of a single vertebra.

II. Other Changes
   1. Arteriosclerosis and calcinosis of the heart.
   2. Calcific deposits in dense soft tissues about joints.
   3. Subcutaneous calcifications.
   4. Calcifications at junctions of ribs and costal cartilages.

CASE REPORT

E. K., a 68-year-old white male, was admitted to the hospital Nov. 19, 1949, in a semistuporous state, with evidence of uremia and acidosis. His wife stated that he had been ill for a considerable time (not specified).

The patient's past history was negative except for gonorrhea at the age of twenty; inflammatory rheumatism of the knees, ankles, and wrists, the last attack occurring twelve years earlier; a left inguinal herniorrhaphy; urinary frequency and nocturia for many years. He received a pension for myocarditis, aortic insufficiency, and arthritis.

Physical examination showed an extremely ill, comatose male with a modified Cheyne-Stokes type of respiration. There was some limitation of neck motion, believed to be due to cervical arthritis. No cervical adenopathy could be detected, but there was moderate distention of the neck veins. The pupils were equal. The conjunctivae were pale. There was some dried blood in the nasal passages. Marked dehydration was evident in the oral mucosa and the breath had a foul odor. Moist sticky râles were heard through both lung fields with decreased breath sounds and dullness in the right lower posterior chest. The heart seemed enlarged but no murmurs were heard. The abdomen was distended, with the liver palpable below the costal margin. The spleen was not felt. Peristalsis was normal. There was pronounced edema of the scrotum. The skin showed excoriations over the chest and abdomen.

Fig. 2. Lumbar spine showing bizarre osteosclerosis plus degenerative osteoarthrosis.

The clinical course at first showed improvement. A urological consultation was obtained and the prostate was found to be small, flat, and fibrotic, with no palpable nodulation. There was only 3 c.c. of residual urine. The patient denied hematuria but admitted to having urinary frequency and nocturia. Repeated urine studies throughout his hospital stay were similar, showing a specific gravity around 1.010; albumin 2 to 4 plus; no sugar; *p*H of 5.5; many pus cells, a few red cells, and a few finely granular casts. Urine cultures consistently yielded *Aerobacter aerogenes*. The blood urea nitrogen varied from 140 to 168 mg. per cent. The acid phosphatase was 0.4 Shinowara units (normal 0–1.1), and the alkaline phosphatase between 6.1 to 9.0 Shinowara units (normal 1.5–5.0). There was never any clinical evidence of prostatic neoplasm.

Other laboratory findings were as follows: CO_2-combining power ranging from 58 volumes per cent down to 14 terminally; total blood protein 5.1 gm.,

with A/G ratio of 1.0; blood calcium 7.6 to 9.4 mg. per cent; inorganic blood phosphorus 9.4 mg. per cent; blood potassium 25.0 mg. per cent; sodium 291 mg. per cent; red cell count from 2.2 to 3.7 million; white cells from 3,500 to 10,200, with an essentially normal differential count; positive blood and spinal fluid serology. An electrocardiogram showed auricular fibrillation and right bundle branch block. Sigmoidoscopy and barium enema studies were normal. The pleural fluid was negative for malignant cells, and a sternal marrow biopsy was also negative. No parasites were found in the feces.

Fig. 3. Pelvis and upper femurs showing combination of productive and destructive lesions, with osteosclerosis predominating.

Radiographic studies of the entire spine, pelvis, and the upper femurs (Figs. 1–3) revealed a bizarre appearance, showing a marked osteosclerotic reaction. The skull appeared normal (Fig. 4). The radiographic impression was either atypical Paget's disease or atypical metastases, as from a prostatic carcinoma. The clinicians believed the bone changes to be due to Paget's disease and not to prostatic metastases, since the prostate was not nodular or enlarged, the acid phosphatase was normal, and there was no bone pain in association with the lesions.

On Dec. 27, severe dyspnea suddenly developed, with both radiographic and physical signs of a pericardial effusion. Pericardial paracentesis yielded 350 c.c. of bloody fluid. From this time on, the course was downhill, with an electrolytic imbalance and an increasing blood urea nitrogen. Death occurred two months after admission.

The pertinent autopsy findings were as follows. The body was well developed and well nourished. The pericardial cavity contained 400 c.c. of a bloody fluid. Both the parietal and visceral layers of the pericardium were markedly thickened and had a shaggy red appearance. The heart weighed 700 gm. and was symmetrically enlarged. The lungs showed a moderate congestion and no gross or microscopic evidence of pneumonia. The thyroid was normal in size and configuration. The parathyroids, though searched for, were not identified, from which it was inferred that, at any rate, they were not enlarged. The liver weighed 2,200 gm. and showed evidence of passive congestion. The gastrointestinal tract, gallbladder, and pancreas were normal. The spleen weighed 320 gm. and revealed signs of passive congestion. In the brain there was a recent hemorrhage in the left parietal cortical area.

Fig. 4. Skull. No changes demonstrated, although osteosclerotic changes are present in the cervical spine.

The kidneys showed evidence of chronic pyelonephritis grossly and microscopically and were of unequal size, the left being distinctly contracted. Microscopic examination revealed a severe obliterative arteriolar and arterial sclerosis. Numerous glomeruli showed hyaline degeneration. In many areas there was complete replacement of kidney parenchyma by scar formation with heavy lymphocyte infiltration. Evidence of chronic inflammatory reaction was present in sections of the renal pelvis. The bladder was normal. The testicles showed a generalized atrophy. The prostate was of average shape and size, and on cut section and microscopically the appearance was normal, with no evidence of malignancy.

The bone marrow (Fig. 5) of the vertebrae and sternum was grossly very hard and sclerotic. Microscopically, there was evidence of diffuse osteosclerosis, with resulting encroachment on the marrow spaces. The latter contained dilated blood vessels and myeloid marrow, and careful search failed to reveal any carcinoma cells. In the absence of a neoplasm, it was felt that the diffuse osteosclerosis had probably resulted from long-standing renal insufficiency. There was no evidence of Paget's disease.

The *anatomical diagnoses* were as follows: chronic pyelonephritis with uremia; uremic pericarditis; diffuse osteosclerosis apparently developing on a basis of chronic renal insufficiency; congestive heart

failure; old healed mitral and aortic valvulitis (rheumatic); generalized arteriosclerosis; old syphilis (treated, seropositive); left herniorrhaphy.

DISCUSSION

Osteosclerosis due to an osteoblastic reaction can occur in many different conditions. It has been shown in association with chronic renal insufficiency in rare instances and this entity is therefore to be added to the list of differential diagnostic possibilities when osteosclerotic changes are encountered. Superficially the present case radiographically simulated one of prostatic osseous metastases or atypical Paget's disease, but actually showed none of the classical findings of either, being more bizarre in its appearance. Postmortem examination excluded other causes for the osteosclerosis, and the findings were considered pathologically compatible with those seen in reported instances of chronic low-grade renal insufficiency.

Fig. 5. Photomicrograph of representative field of densely sclerotic bone from one of the vertebral bodies. The architecture is in no way suggestive of Paget's disease, nor were any carcinoma cells found within the marrow spaces. × 40

CONCLUSIONS

1. A brief summary of the etiology, pathology, and radiographic findings in chronic renal insufficiency is given.

2. A report of a case with unusual osseous manifestation of chronic renal insufficiency, namely osteosclerosis, is presented.

NOTE: The author wishes to express his appreciation to Dr. C. W. McClanahan, Chief of the Radiological Service, VA Center, Los Angeles, Calif., for his counsel and interest in the preparation of this paper; also to Dr. Louis Lichtenstein for reviewing the pathological slides in this case.

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SUMARIO

Los Hallazgos Radiográficos Oseos de la Insuficiencia Renal Crónica

La insuficiencia renal crónica es capaz de producir alteraciones de variada intensidad y forma en el sistema óseo. En los casos menos avanzados, la depleción del calcio orgánico, secundaria a la concomitante acidosis constitucional, tiende a provocar osteoporosis. Sin embargo, cuando la insuficiencia renal es prolongada, puede haber períodos durante los cuales tiene lugar reparación en forma de neosteogenia. Cuando ésta predomina sobre el proceso de reabsorción, puede sobrevenir una osteosclerosis generalizada.

Comunícase un caso de este último género. El aspecto roentgenológico era de notable reacción osteosclerótica que abarcaba el raquis, la pelvis y la porción superior de los fémures. El cuadro se consideró como debido posiblemente a enfermedad de Paget o metástasis de carcinoma prostático, pero ambas posibilidades fueron excluídas en la autopsia. El diagnóstico definitivo fué pielonefritis crónica con uremia; osteosclerosis difusa aparentemente secundaria a insuficiencia renal crónica.

Hereditary Multiple Diaphyseal Sclerosis (Ribbing)[1]

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IN 1949 RIBBING (3) described a peculiar form of diaphyseal sclerosis which he had observed in four of six siblings and which differed in some respects from any lesions previously reported. He was unable to determine the cause or nature of the condition and gave it the name of hereditary multiple diaphyseal sclerosis. We have observed two examples, occurring in brothers, of a type of sclerosis resembling that described by Ribbing. Since this appears to be an unusual form of bone disease or dysplasia we are reporting our cases at this time.

The essential finding in this disease consists in a fusiform thickening of a portion of the diaphysis of a long bone. The involved area is extremely dense and the cancellous structure largely or completely obliterated. The lesions have been quite similar in their roentgen appearances, varying only in the length of the involved area and the intensity of the sclerosis. There is a tendency toward symmetrical changes and to multiplicity of bones involved, with the tibia and femur most frequently affected. The ends of the shafts are normal. The general health of the patients has been unimpaired, and other congenital stigmata have been absent (exception, our Case 2). The lesions may exist without symptoms or may cause local pain of a deep boring character. The time of onset of the sclerosis is unknown, but in none of the cases have symptoms begun before puberty.

A brief résumé of Ribbing's cases is given below:

1. Father, dead at age 68. No record of any skeletal roentgenograms.
2. Mother, living, age 63. No symptoms of osseous disease. Skeletal roentgen study showed normal findings.
3. Son, born May 7, 1905. No symptoms; skeletal roentgenograms normal. Has three children, all with normal skeletal roentgenograms.
4. Daughter, born Nov. 8, 1906. No symptoms; skeletal roentgenograms normal. Has three children, all normal.
5. Daughter, born April 17, 1914. Beginning in 1940, experienced pain in both legs. The pain in the right leg had shown improvement since 1944 and there had been some improvement in the left. In 1941 roentgenograms showed a 7-cm. area of thickening and sclerosis in the middle of the right tibia. There was some increase in the lesion by the end of 1942 and at this time a similar lesion was observed in the left tibia. In 1948, examination showed a marked eburnation about 20 cm. in length in each tibial shaft. The medullary cavity was practically obliterated and the outline of the bone slightly expanded. Examination of the remainder of the skeleton showed a similar sclerosing lesion in the left femur and another in the distal part of the left radius. The patient has one child, whose skeletal roentgenograms are normal.
6. Son, born April 12, 1918. Suffered an injury to the left leg in 1940 by a blow. This was followed by a week of discomfort and then subsidence of symptoms. Several months later a firm swelling was noticed at the site of the former injury. A half year later the patient experienced pain in the leg, resembling a toothache. Roentgenograms at this time showed a moderate fusiform expansion of the tibial diaphysis with considerable cortical thickening. This was diagnosed as a traumatic periostitis. Examination in 1948 showed some upward extension of the sclerosis and the cortical bone had become more thickened and dense. The rest of the skeleton was normal. The patient has three children, but roentgen studies could not be obtained on them.
7. Daughter, born May 23, 1923. Never any skeletal symptoms and no abnormal physical findings. Skeletal roentgenograms showed sclerosing lesions in both femurs and a small lesion in the upper part of the left tibia.
8. Daughter, born March 10, 1928. Toward the end of 1945 suffered from a dull pain in the

[1] From the Department of Radiology of the University of Wisconsin and the State of Wisconsin General Hospital, Madison, Wisc. Accepted for publication in May 1952.

forehead and was treated for anemia. In early 1946 she observed a spot in her right leg below the knee which was painful when she sat down. The pain increased and the leg began to swell. Examination revealed a diffuse fusiform thickening in the upper half of the tibia. In January 1947, a biopsy was taken, which was reported as showing osteosclerosis. In January 1948, a similar sclerosing lesion was found in the left tibia and the one in the right tibia had undergone some advance. Further skeletal studies revealed a small lesion in the upper part of the left fibula, the femurs being normal. A biopsy specimen from the right tibia was described as follows: "The pathological process consists in cortical osteosclerosis, to all appearances principally affecting the superficial (subperiosteal) portion of the cortical layer. There is thus periosteal, exceedingly dense new bone formation, which without clear demarcation fuses partly into the profound, normal stratum of the cortical bone, and partly, in the longitudinal direction of the bone, into the adjacent normal osseous tissue. However, the layer of new bone is made conspicuous not only by its eburnous structure with very narrow haversian canals, but also by generally indistinct lamination. Particularly around the vascular canals, etc., the lamellae fail to show regular, concentric arrangement, being more or less straightened."

Ribbing was of the opinion that his cases differed from any previously reported, including those now known as Engelmann's disease or progressive diaphyseal dysplasia (Neuhauser *et al.*) (1, 2). At the present time there are approximately 14 cases in the literature which resemble Engelmann's disease or have been reported as instances of this condition. In none of these have familial influences been recorded, although it is probable that few such studies have been made. However, other differences are apparent. In the reported cases of Engelmann's disease the lesions have been found at an earlier age and the bone disease appears to be only a part of a much more widespread disorder. There are disturbances of gait and of posture, neurological findings, and other signs indicating that systems in addition to the osseous are affected. In Ribbing's cases the patients were of normal physical and mental development and except for local symptoms were considered healthy. An exception is to be noted in our cases in that there is a distinct familial tendency to otosclerosis and one of the patients suffered from this condition.

In addition to his own cases, Ribbing cites a personal communication from Feddema of Holland, who examined members of a family with apparently the same condition. Of five siblings, all showed lesions of varying degrees of severity but only two complained of pain. In all five the lesions were in the tibias.

The two patients with diaphyseal sclerosis observed by us were brothers, members of a family in which there was a distinct hereditary tendency to otosclerosis. We are indebted to Dr. Hans Reese for the family history of these patients. The family consists of the following:

1. Father, age 62, living and well. No skeletal roentgenograms available.
2. Mother, age 61, living and well. No roentgenograms available.
3. Son, J. H., age 35 (Case 2 below). Has otosclerosis and osteosclerosis.
4. Daughter, Mrs. C. B., age 33. Has otosclerosis. The bones are normal on roentgen study.
5. Son, W. H., age 31 (Case 1 below). Has osteosclerosis but no otosclerosis.
6. Daughter, Mrs. G. L., age 28. No otosclerosis. No roentgen studies available.

In addition, two maternal uncles have otosclerosis. Thus far we have been unable to obtain roentgenograms of these individuals.

The case histories of W. H. and J. H. follow:

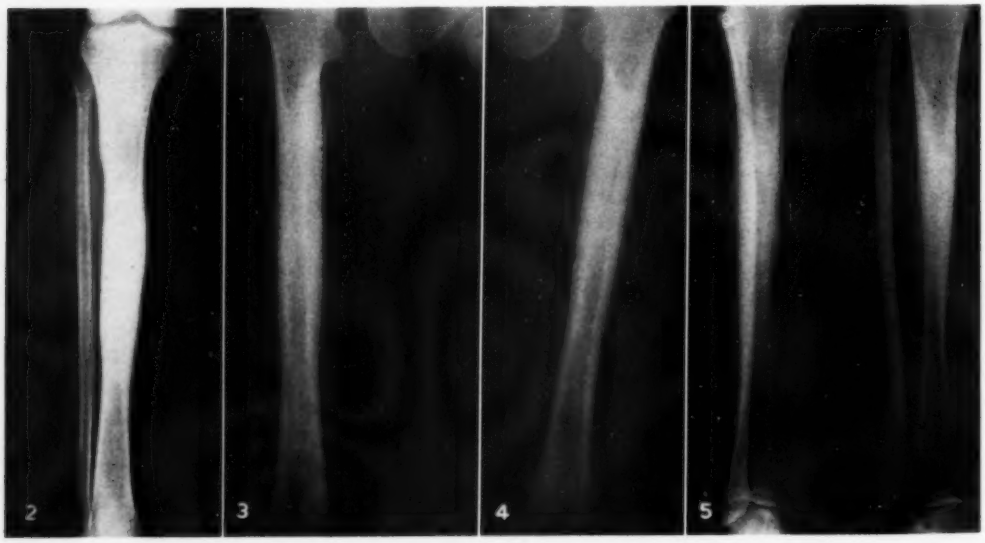
CASE 1: W. H., white male. In 1941, at the age of 20, he received a routine physical examination as an entering student at the University of Wisconsin. The examiner noted a swelling in the right tibia and requested roentgenographic examination. This showed an area of dense sclerosis about 10 cm. in length in the shaft of the tibia (Fig. 1). The bone was thickened and the medullary cavity could not be made out in the involved area. The upper and lower portions of the bone were quite normal. The lesion was considered to represent an area of low-grade osteitis of Garré type. No further follow-up was obtained until March 9, 1948, at which time the patient gave the following history. In 1939, while with the Civilian Conservation Corps, he had begun to have pain in the *left* leg. He was sent to Fitzsimons General Hospital in Denver, where he was

Fig. 1. Case 1. Right leg, Sept. 25, 1941. Fusiform sclerosis in the mid third of the tibia. The medullary canal is obliterated, apparently due to thickening of the cortex.

kept under observation for three months without any specific treatment. Following this he had had no difficulty until 1948, when aching in the leg developed, especially after walking and skating. There had been no injury and there were no other symptoms.

Physical examination revealed no pertinent findings; the blood count and sedimentation rate were normal and the blood serology was negative on three occasions. Skeletal roentgen surveys were done and sclerosing lesions were found in both tibias, both femurs, the left fibula, and the right radius (Figs. 2–5). Because of the multiplicity of the lesions and their appearance, the question of syphilis was raised, but there was no laboratory or clinical support for this diagnosis. A biopsy of the left tibia was carried out and the pathological report indicated "chronic osteoperiostitis, sclerotic, non-suppurative, cause undetermined." There has been no further follow-up.

CASE 2: J. H., male, age 35, brother of W. H. This patient had noted episodes of double vision and drooping of the lids for about two years. He had experienced, also, a gradual impairment of hearing in the left ear. He had been in good health until the onset of the present complaints. He is now (1950) a postgraduate student in the University of Wisconsin. He is married and has two children both living and well.



Figs. 2–5. Case 1.

Fig. 2. Right leg, May 9, 1948. In the nearly seven years since the previous examination there has been a slight advance in the extent of the lesion.

Fig. 3. Right femur, May 9, 1948. Sclerosing lesion in middle third and some cortical thickening in the lower half.

Fig. 4. Left femur, May 25, 1948. Lesion in shaft similar to that present in the right femur. The femoral lesions were asymptomatic.

Fig. 5. Left leg, May 25, 1948. Long areas of involvement in shaft of fibula and another lesion in the mid shaft of the tibia.

Figs. 6–8. Case 2.

Fig. 6. Legs, Oct. 16, 1950. Areas of cortical sclerosis in both tibial shafts. The cortex is thickened both internally and externally, with encroachment on the medullary canal but without completely obliterating it. The fibulas are normal. The lesions were asymptomatic.

Fig. 7. Left femur, Oct. 16, 1950. Small area of sclerosis mainly on the inner side of the upper part of the shaft. The right femur was normal.

Fig. 8. Forearms, Oct. 16, 1950. Small area of sclerosis involving the inner cortex of the left ulna. The other bones are normal.

Physical examination revealed an ocular muscle imbalance with paralysis of the left lateral rectus. Examination by the otologic service revealed findings indicative of left-sided otosclerosis. Results of examinations of the blood and urine were within normal limits. The blood Wassermann reaction was negative. The spinal fluid showed a gold sol curve of 444321000 and a protein of 60 mg. per cent. It was felt that the patient was suffering from an ocular type of myasthenia gravis, which accounted for the ocular findings.

Because his brother was known to have bizarre sclerotic bone lesions, skeletal roentgen studies were carried out. There were found areas of sclerosis in both tibias, the left femur, and the left ulna (Figs. 6–8). The other bones, including the skull, were normal. There had never been any symptoms referable to any of the bone lesions.

DISCUSSION

The lesions of hereditary multiple diaphyseal sclerosis are rather similar roentgenologically to those of Engelmann's disease in that in both conditions there is a fusiform thickening of the diaphysis. Here the similarity ends. In Engelmann's disease the lesions have been much more widespread and symmetrical, they appear at an earlier age, there are disturbances of gait and of posture, retardation of growth in height and weight, and other signs of a more generalized involvement of multiple systems. No cases have been reported in which hereditary influences are apparent. The pathologic findings, as reported by Neuhauser *et al.*, have consisted in new bone deposition associated with progressive bone absorption; in Ribbing's case and in ours there was only new bone formation.

Other than the cases of Engelmann's disease, there are no other conditions which resemble the lesions under discussion. In our first case, before it was realized that multiple lesions were present, the process in the tibia was considered to be a low grade osteitis of Garré type. This diagnosis was a reasonable one, since the individual lesions resemble those usually described as examples of this condition. The error in this case points up the fact that the diagnosis of sclerosing osteitis should be made with caution, since it will frequently be wrong. It also suggests that when unusual lesions of bone are encountered, complete skeletal roentgenograms may well be in order; also that skele-

tal studies of other members of the family may be revealing.

SUMMARY AND CONCLUSIONS

Hereditary multiple diaphyseal sclerosis is a rare condition characterized by the occurrence of one or more areas of dense diaphyseal sclerosis in two or more members of the same family. The lesions may be symptomatic or may be found without symptoms. In the former cases the only clinical signs are those of aching pain in the involved extremity and, in some, palpable thickening of the bone. The age of onset is unknown, but pain, when it occurs, has begun at or after puberty. Serial studies show a slow progression for some years, after which the lesions apparently become stationary and symptoms disappear. The present evidence suggests that the disease represents a rare familial dysplasia, but thus far the exact cause and nature of the process remain completely unknown.

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ADDENDUM

Since submitting this manuscript for publication, the infant son of W. H. (Case 1) was brought in for examination because of difficulty in walking. Roentgenograms show multiple sclerosing lesions in the shafts of most of the long bones. The clinical and roentgen findings resemble closely those of Engelmann's disease. Further study of this child, including bone biopsy, will be done and may shed further light upon the relationship of the lesions described in this paper and those of Engelmann's disease.

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SUMARIO

Esclerosis Múltiple Hereditaria de las Diáfisis (Ribbing)

La esclerosis diafisaria múltiple hereditaria, descrita por primera vez por Ribbing, es un estado raro caracterizado por la existencia de zonas de densa esclerosis de las diáfisis en dos o más miembros de una familia. Las lesiones pueden ir o no acompañadas de síntomas. En los casos sintomáticos, los únicos signos clínicos son dolores sordos en el miembro afectado y, en algunos casos, engrosamiento palpable del hueso. Desconócese la edad de la iniciación, pero el dolor, cuando existe, comienza después de la pubertad. Los estudios roentgenológicos seriados revelan avance lento durante algunos años, después de lo cual las lesiones aparentemente se estacionan y desaparecen los síntomas. Los datos actuales sugieren que la enfermedad representa una rara displasia familiar, pero permanecen en la obscuridad la causa y la naturaleza exactas del proceso.

Preséntanse 2 casos en hermanos.

Diaphragmatico-Pericardial Tear with Intrapericardial Herniation of the Transverse Colon[1]

JOSEPH STEIN, M.D.,[2] HENRY P. COLMORE, M.D.,[3] and ROBERT A. GREEN, M.D.[4]

HERNIATION OF the abdominal contents into the chest through a diaphragmatic hernia or through a traumatic diaphragmatic tear is not uncommon. The case to be reported here is of special interest because of the rarity of the type of herniation observed, the long delay which preceded the diagnosis, and the unusual fashion in which the clinical and radiological picture simulated cardiac disease.

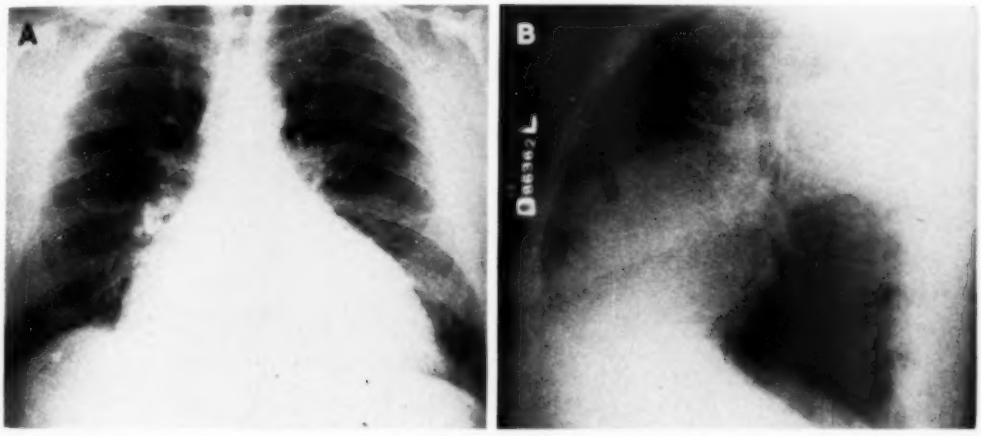

Fig. 1, A. Postero-anterior roentgenogram of chest showing markedly enlarged cardiovascular silhouette. B. Lateral projection. Note retrosternal gas shadows of colon pattern.

CASE REPORT

A 45-year-old white male physician had felt well until May 1946, when he experienced tachycardia, fatigue, and slight dyspnea following moderate exertion. He was overweight and attributed the symptoms to obesity. In 1947 he had an episode of chest pain during exertion in cold weather, which he interpreted as an anginal attack. In 1948, frontal headaches developed. At this time, an enlargement of the cardiac contour was demonstrated roentgenologically, and the patient's past history was obtained. On June 20, 1943, while on service with the Armed Forces in North Africa, he had been in a jeep accident which caused mild cerebral concussion and a fracture of the right clavicle. He also received at that time a heavy blow to the precordial area, producing substernal pain and tenderness which lasted for about six weeks. An electrocardiogram in 1944 was normal.

Further roentgenologic study in 1948 and 1949 indicated cardiac enlargement of unknown etiology and the patient was advised by one physician to give up his medical practice and to restrict his activities. From May to September 1950 he was hospitalized elsewhere for extensive observation. Roentgenkymography showed diminished pulsations along the right and left borders of the heart. Venous pressure and circulation times were normal. Bromsulfalein retention was 13 to 15 per cent. No other abnormal findings were elicited. Digitalization was without effect. No definitive diagnosis was reached. Angiocardiography, pericardial paracentesis, and exploratory thoracotomy were recommended but refused by the patient.

Admission to the Medical Service of the Veterans Administration Hospital (Bronx, N. Y.) was on Dec. 30, 1950. The pertinent abnormal physical findings included moderate emphysema of the chest, distant heart sounds, a mild diastolic hypertension in both arms (130/95), enlargement of the heart manifested by extension of the cardiac dullness

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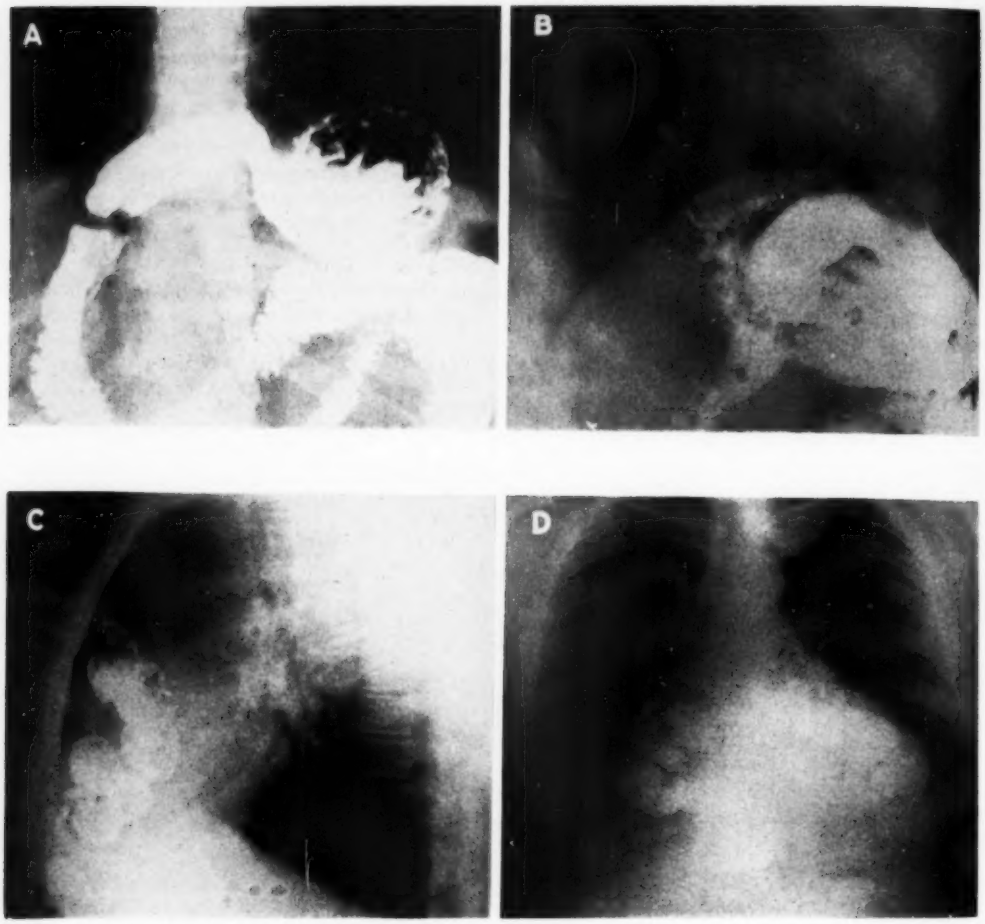

Fig. 2, A and B. Organo-axial volvulus of stomach. C and D. Large segment of transverse colon contained within the pericardium (seen on barium-enema examination).

to the anterior axillary line, some enlargement of the liver (two fingers below the costal margin), and a vague "fullness" in the left upper quadrant of the abdomen.

A hemogram was normal, as were the sedimentation rate, urinalysis, and serology. Liver function studies showed a thymol turbidity of 8.0 units, and a bromsulfalein retention of 16 per cent, without other abnormalities. An electrocardiogram was normal. A postero-anterior chest roentgenogram (Fig. 1A) showed generalized enlargement of the cardiac contour, while a lateral view (Fig. 1B) showed several radiolucent zones overlying the anterior aspect of the heart just posterior to the sternum. This was felt by the Radiology Service to be consistent with gas in the bowel and was so reported. Fluoroscopic examination showed diminution in the amplitude of pulsations of each of the lateral heart borders.

An upper gastrointestinal series, including a small bowel study, showed a peculiar anatomic distortion of the stomach, indicating organoaxial volvulus (Fig. 2A and B). Barium-enema studies confirmed the impression that herniation of the bowel into the chest was present. A considerable segment of the transverse colon was seen to lie retrosternally and on either side of the mid-line (Fig. 2C and D). No other abnormality was observed in the large bowel.

After preliminary weight reduction, surgery was performed on Feb. 16, 1951. A tear measuring 7.5 cm. was found in the left leaflet of the diaphragm anteriorly at the junction of the membranous and tendinous portions. Through this opening a large segment of the transverse colon extended directly into the pericardial sac. The only adhesion to the colon was a small one at the ring of the opening of the diaphragm. The colon was replaced in the

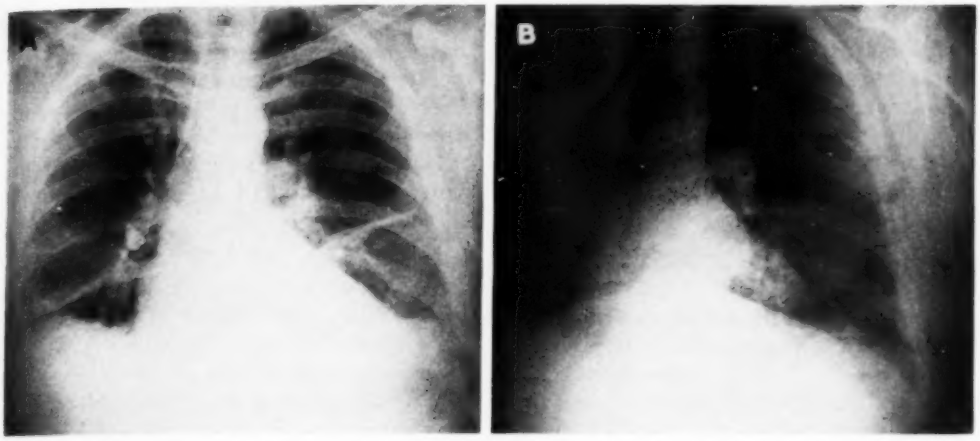

Fig. 3, A. Postero-anterior chest roentgenogram on fifth postoperative day. Cardiac silhouette considerably smaller than in Fig. 1, A. B. Postero-anterior roentgenogram on seventh postoperative day, within normal limits.

peritoneal cavity, and the diaphragmatic rent was sutured.

The postoperative course was relatively uneventful and the patient made a good recovery. A chest roentgenogram taken on the fifth postoperative day demonstrated a marked reduction in size of the cardiac silhouette (Fig. 3A). Two days later it was normal in size, shape, and position (Fig. 3B). A postoperative gastrointestinal series and barium enema study were normal.

The patient rapidly recovered his strength and sense of well-being and at the present writing is carrying on a full-time medical practice.

COMMENT

Traumatic diaphragmatic herniations are not uncommon. They should be considered particularly in obscure thoracic conditions and especially where organoaxial volvulus of the stomach is found and a history of trauma is elicited. In this instance several unusual situations were present: (1) The patient was a physician who was treated for heart disease and became a "cardiac invalid" to the extent that he was forced to give up his medical practice. (2) The true nature of the findings was apparently not suspected until a routine lateral chest roentgenogram was done approximately four and a half years after "cardiac enlargement" was diagnosed. (3) A barium enema study confirmed the radiologic impression that a hernia might be present. (4) The finding at operation of herniation of a segment of the transverse colon into the pericardial sac is highly unique. (5) The patient made a complete transition from a "cardiac cripple" to an actively practicing physician.

NOTE: The authors wish to express their thanks to Dr. Harold G. Jacobson, Chief of the Radiology Service, for aid in preparing this manuscript, and to the Medical Illustration Department for the photographs.

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SUMARIO

Desgarro Diafragmático-Pericardíaco con Hernación Intrapericardíaca del Colon Transverso

Preséntase un caso extraño de hernia traumática a través del diafragma. El enfermo comunicó antecedentes de haber recibido un golpe violento en la zona precordial en 1943, lo que ocasionó dolor e hiperalgesia substernal por seis semanas. De 1946 a 1948 experimentó síntomas de vez en cuando y en 1948 y 1949 el estudio radiológico reveló hipertrofia cardíaca. La verdadera situación fué sospechada por primera vez en 1951, al mostrar una radiografía lateral del tórax zonas radiolucientes

sobre la cara anterior del corzón, precisamente detrás del esternón, indicando presencia de gas en el intestino. Una serie de radiografías gastrointestinales indicó vólvulo organo-axil y los estudios con enema de bario confirmaron la impresión formada de herniación intratorácica del intestino.

Al operar, se descubrió un desgarro que medía 7.5 cm. en la hojilla izquierda del diafragma, a través del cual un gran segmento del colon transverso se extendía directamente al saco pericardíaco. A continuación de la reposición del colon en la cavidad peritoneal y reparación de la solución de continuidad en el diafragma, la curación fué absoluta.

Mechanisms in Acquired Radioresistance of Cancer[1]

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ACQUIRED radioresistance in cancer of various types is a phenomenon all too common in the radiotherapist's experience. The lymphomas as a group appear to be among the most outstanding examples of human cancers which may exhibit this finding. To explain it, many theories are recorded in the literature; few experimentally established facts, however, are available. The purpose of this paper is to present negative data obtained by studying the effects of *in vitro* irradiation on a transplantable lymphoma in order to determine whether acquired radioresistance is a property of this tumor cell or the host.

METHODS

The Gardner mouse lymphosarcoma 6C3HED was used throughout the experiment.[2] The tumor was carried subcutaneously in young adult C3H mice obtained from the Roscoe B. Jackson Memorial Laboratory in Bar Harbor, Maine. All transplants were made under sterile conditions by the trocar implantation of one small (2 mm. in diameter) pellet of freshly excised tumor into the subcutaneous tissue of the lateral abdominal wall. All x-irradiation treatments were given with a G. E. Maximar Therapy Unit at 200 kv., with 3 mm. aluminum inherent filtration, target distance of 35.6 cm., and an output of 165 r per minute. The tumor to be transplanted was excised from a freshly killed animal and cut into small fragments, which were placed in Wassermann tubes with 2 ml. of Hank's balanced salt solution. The controls were set aside and the treated fragments were irradiated in the Wassermann tubes. Both controls and the irradiated fragments were then implanted subcutaneously into normal animals. In 200 control transplants made in this fashion the tumors invariably grew well, attaining a size which necessitated transfer in twelve days.

The animals were kept in separate cages and received the standard diet employed in this institution.

The experiment was divided into two parts. The object of the first was to establish the lethal dose for this tumor under the conditions outlined above, *i.e.*, the *in vitro* dose of radiation sufficient to prevent growth of the tumor fragment when transplanted into a normal animal. This was determined by giving tumor fragments single *in vitro* doses of radiation varying from 2,500 to 5,000 r and then implanting them into normal animals.

The second part of the experiment consisted in an attempt to demonstrate under these *in vitro* conditions of x-irradiation the phenomenon of acquired radioresistance. To accomplish this, the originally unirradiated tumor was given increasing *in vitro* doses of radiation with each successive transplanation. The initial dose was well below the lethal dose for the tumor, and increasing doses were given at each transplantation in order to accustom the tumor to the effects of radiation, with the hope that the lethal dose for the previously unirradiated tumor could thus be exceeded. No attempt was made to determine the possible influence of time upon the induction of radioresistance.

RESULTS

In Table I are summarized the single *in vitro* x-radiation doses given each tumor fragment and the number of animals into

[1] From the Cancer Research Institute, New England Deaconess Hospital, and the Laboratory of Pathology, Harvard Cancer Commission, Boston, Mass. This work was done under U. S. Atomic Energy Commission Contract AT(30-1)-901 with the New England Deaconess Hospital. Accepted for publication in April 1952.

[2] This tumor was supplied to us by the Jimmy Fund Building of the Children's Cancer Research Foundation, Boston, Mass., through the courtesy of Dr. Israel Diamond.

TABLE I: LETHAL X-RADIATION DOSAGE DETERMINATION

X-ray Dose in Roentgens	Number of Animals Receiving Irradiated Implants	Number of Animals With Tumors After Irradiation of Implants	Number of Animals Without Tumors After Irradiation of Implants
2,500	3	3	0
3,000	7	3	4
3,500	12	0	12
4,000	6	2	4
4,500	5	0	5
5,000	2	0	2
Controls	17	17	0

ments were given, *in vitro*, 4,000 r x-radiation and implanted into two normal mice. Two fragments were given, *in vitro*, 5,000 r x-radiation and implanted into two normal mice. Two fragments were given, *in vitro*, 6,000 r x-radiation and implanted into two normal mice.

In both of the mice receiving the implants which were treated *in vitro* with 500 r tumors developed. One of these was freshly excised and cut into fragments. Two of these tumor fragments were implanted, without additional irradiation, into two normal mice; two were given 500 r of x-irradiation *in vitro* before implantation; two 800 r; two 1,000 r; one 2,000 r; one 3,000 r; one 4,000 r.

TABLE II: SURVIVAL OF TUMOR TRANSPLANT AFTER PROGRESSIVE IRRADIATION
(Tumors Indicated by Boxes and Joined by Double Lines Were Used as the Progressive Transplants)

Date of Transplant, Oct. 16, 1951		Date of Transplant, Oct. 29, 1951		Date of Transplant, Nov. 14, 1951		Date of Transplant, Nov. 29, 1951		Date of Transplant, Dec. 13, 1951		Date of Transplant, Jan. 4, 1952		Date of Transplant, Jan. 24, 1952	
X-ray Doses (r)	No. of +, − Mice	X-ray Doses (r)	No. of +, − Mice	X-ray Doses (r)	No. of +, − Mice	X-ray Doses (r)	No. of +, − Mice	X-ray Doses (r)	No. of +, − Mice	X-ray Doses (r)	No. of +, − Mice	X-ray Doses (r)	No. of +, − Mice
500	+ ⊕	500	+ +	900	⊕ −	1,100	⊕ +	1,200	+ +	2,500	− −	3,000	− −
2,000	+ +	800	⊕ −					1,400	+ +	3,000	⊕ +	3,200	− −
4,000	+ +	1,000	+ −					1,700	+ +	4,000	− −	3,500	− −
5,000	− −	2,000	+					1,800	⊕ −	5,000	− −	4,000	− −
6,000	− −	3,000	+										
		4,000	−										
Controls	+ +	Controls	+ +	Controls	+ +	Controls	+ +	Controls	+ +	Controls	+ +	Controls	+ +

In Table II are summarized the results of the second half of the experiment.

A previously unirradiated tumor was freshly excised and cut into fragments. Two fragments were implanted into two normal mice. Two fragments were given, *in vitro*, 500 r x-radiation and implanted into two normal mice. Two fragments were given, *in vitro*, 2,000 r x-radiation and implanted into two normal mice. Two fragments were given, *in vitro*, 4,000 r x-radiation and implanted into two normal mice. Two fragments were given, *in vitro*, 5,000 r x-radiation and implanted into two normal mice. Two fragments were given, *in vitro*, 6,000 r x-radiation and implanted into two normal mice.

In both of the mice receiving the implants which were treated *in vitro* with 500 r tumors developed. One of these was freshly excised and cut into fragments. Two of these tumor fragments were implanted, without additional irradiation, into two normal mice; two were given 500 r of x-irradiation *in vitro* before implantation; two 800 r; two 1,000 r; one 2,000 r; one 3,000 r; one 4,000 r.

In one of the two mice receiving tumor fragments which had been irradiated with 800 r a tumor developed. This tumor was also excised and cut into fragments. Two of the fragments were implanted into normal mice, while two were given 900 r irradiation before implantation.

A tumor developed in one of the two mice implanted with these irradiated fragments and this was in turn excised and cut into fragments. Two fragments were implanted without irradiation into two normal mice, and two were implanted in two normal mice after irradiation *in vitro* with 1,100 r.

In both of the animals into which the tumor fragments irradiated with 1,100 r were implanted, tumors developed. One of these tumors was excised, and, as before, two fragments were implanted into normal mice. Two were given 1,200 r *in vitro* before implantation; two 1,400 r; two 1,700 r; two 1,800 r.

In one of the two mice receiving tumor fragments irradiated *in vitro* with 1,800 r a tumor arose. Fragments of this tumor were implanted into two normal mice; two fragments were given 2,500 r x-radiation before implantation; two 3,000 r; two 4,000 r; two 5,000 r.

Tumors developed in both of the mice implanted with fragments which had received 3,000 r. Fragments of one of these tumors were implanted in two normal mice, while two fragments were given 3,000 r, two 3,200 r, two 3,500 r and two 4,000 r before implantation. No tumors were produced by the fragments receiving this additional irradiation.

The + signs in Table II indicate those animals in which tumors developed after the implantation of x-irradiated tumor fragments. The double line joins together the progressive doses of x-radiation given the fragments *in vitro* just before implantation into normal mice. All negative animals were observed for three weeks. Hematoxylin and eosin-stained sections were made of all the tumors grown from fragments given progressive *in vitro* x-irradiation. No differences were observed in the general cellular morphology of the unirradiated tumor and the progressively irradiated tumor. As may be seen by inspection of Table II, it was not possible to induce radioresistance in this tumor under the conditions of the experiment. The progressively *in vitro* irradiated tumor fragment failed to grow after the same or a slightly lower dose of irradiation which killed the previously non-irradiated tumor fragments as observed in the first half of the experiment. When the *in vitro* lethal dose of 4,500 r was reached, the transplant failed to grow whether or not it had been progressively irradiated.

DISCUSSION

The mechanisms of acquired radioresistance in cancer are a controversial subject. The theories designed to explain the accepted clinical phenomenon may be divided into three groups. *First* is the theory that subcancerocidal doses of x-rays kill all but the radioresistant cells of the tumor, so that when a recurrence takes place it is the resistant cells which comprise the tumor. *Second* is the theory that acquired resistance depends upon x-ray-induced mutations in the cancer cell, so that in some way there has developed in the recurrent tumor a metabolism capable of withstanding larger and larger doses of radiation. *Third* is the theory that the phenomenon may be explained on the basis of the host's reaction to radiation rather than by a change in the radiosensitivity of the tumor cells themselves.

These three theories were ably discussed in a review of the subject by Windholz (1). He concluded that acquired resistance is best explained by an irradiation-induced metabolic mutation of the tumor cells, the essential nature of which is unknown.

This experiment indicates that transplanted Gardner mouse lymphosarcoma 6C3HED cells were not made radioresistant by increasing sublethal doses of x-radiation given *in vitro;* and it may well be that the clinical observation of acquired radioresistance cannot be explained upon the basis of either resistant cell survival with resistant tumor recurrence, or x-ray-induced resistant metabolic mutation of the tumor cells and resistant tumor recurrence.

An alternative explanation lies in an alteration of the host-tumor relationship as a result of the host's response to the radiation. Evidence of alteration in this relationship following tumor irradiation is familiar to every pathologist. It consists of x-ray-induced vascular damage, chronic inflammation, and increasing fibrosis in the irradiated region, the results of which are to alter greatly the nutritional supply of the neoplasm and the environment in which it must grow. Lasnitzki (2) has brought

forth good evidence to show that approximately one-third of the final effect of *in vivo* tumor x-irradiation may be accounted for by a direct effect on the tumor cells, while two-thirds of the final effect is due to the response of the host tissues to the irradiation. Further evidence is presented by Elward (3), who noted that lethal doses of x-radiation were unable to kill tumors if the tumors were transplanted immediately after irradiation, and by Russ and Scott (4), who found that irradiation of the tissue surrounding a shielded cancer greatly impeded the subsequent growth of the cancer. In conclusion it should be noted that Robertson was unable to acclimatize the protozoan *Bodo caudatus* to x-irradiation (5).

SUMMARY

1. The transplant survival data obtained when Gardner mouse lymphosarcoma 6C3HED is given increasing *in vitro* doses of x-radiation are presented.

2. The possible mechanisms underlying the well known clinical observation of acquired radioresistance in cancer therapy are discussed.

3. It is concluded from the studies that the mechanism of acquired radioresistance in the Gardner mouse lymphosarcoma is probably an alteration of the host-tumor relationship as a consequence of the host's response to the radiation rather than to a direct effect of the radiation on the tumor cell itself.

NOTE: We wish to acknowledge the technical assistance of Mrs. J. B. Staples.

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SUMARIO

Mecanismos en la Radiorresistencia Adquirida del Cáncer

Estos experimentos fueron llevados a cabo con un linfoma murino transplantable para lanzar alguna luz sobre el mecanismo de la radiorresistencia adquirida del cáncer. Descubrióse que la dosis letal *in vitro* de radiación roentgen para dicho tumor se aproximaba a 4,500 r. El tumor primitivamente no irradiado recibió dosis crecientes *in vitro* de rayos X con cada transplante sucesivo, comenzando bien por debajo de la dosis letal y aumentando en cada transplante para acostumbrar el tumor a los efectos de la irradiación, con la esperanza de poder así exceder la dosis que era letal para el tumor que no había sido irradiado anteriormente.

Sin embargo, los fragmentos del tumor irradiados progresivamente dejaron de desarrollarse después de recibir una dosis de rayos idéntica (o algo menor) a la que destruyó los fragmentos del tumor que no había sido irradiado antes. Esas observaciones indican que las células del tumor usado para estos experimentos no fueron convertidas en radiorresistentes por las dosis subletales crecientes de rayos.

Dedúcese que, en lo relativo a este tumor, el mecanismo de la resistencia adquirida es probablemente una alteración de la relación de huésped-tumor a consecuencia de la respuesta del huésped a la radiación más bien que un efecto directo de la radiación sobre las células neoplásicas mismas.

A Method of Detecting a Questionable Film Artifact[1]

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WHEN IN THE course of development, despite the most careful procedure, two films adhere to each other or to the side of the tank, complete development of the areas in contact is prevented. The exposed silver salts are not completely reduced to metallic silver and there is produced an artifact in the form of an area of decreased density. This will be of varying degree, size, and shape, dependent on the area of contact. The resultant films, after going through the processing cycle, will demonstrate an area on the surface of the involved emulsion which, when viewed by reflected light, shows a higher gloss than adjacent areas where silver has been deposited in the course of normal development.

Recognition of this glossy effect is the method generally used in the detection of such an artifact when it is not already obvious by transmitted light. The usual procedure is to hold the film in such a manner that light will strike it at the proper angle, but occasionally the effect is not sufficiently pronounced and, consequently, the glossy surface is extremely difficult to visualize.

The author has recently seen two such artifacts where the characteristic gloss on the surface was not visible. Under such conditions, the area in question may be difficult or impossible to distinguish from a pathological infiltration of the lung. When this is true, the method to be described will be helpful, in most cases at least, in differentiating an artifact from an actual disease process. It was devised by the author in 1945.

When a light spot in the film is under suspicion, an area of both emulsion surfaces is scratched off, preferably in the form of an "X" centered in the questionable region, with only one line of the "X" on each side of the film. In the absence of an artifact, light transmitted through the lines of the "X" will be equal. If an artifact is present, the light transmitted through the line on the opposite side will be definitely more intense than light through the line on the side of the artifact. These small scratches on the film can be made with a penknife, an ampule file, or any other handy instrument which will scratch off the emulsion without unduly harming the film base. Moistening the area first is helpful. The areas to be scratched need be only about 1 × 4 mm., which is too small to significantly mar the overall diagnostic property of the films.

During the process of removing the dry emulsion as described, it may also be noted that the emulsion on the side of the artifact will scratch off with slightly more difficulty than the normally processed emulsion on the opposite side. This, while not wholly reliable, serves as corroborative evidence.

Figure 1 shows a correctly processed film with an "X"-shaped area in the lung produced by removing the emulsion from one side of the film to form the long bar and from the opposite side to form the short bar. Inspection will show that wherever a single layer of emulsion has been removed, the area is about twice as light as the surrounding area, but otherwise there has been no change. It looks entirely white where the bars of the "X" cross because there all emulsion on both sides has been removed.

Figure 2 shows a large "contact" artifact covering most of the chest, its left hand extent being indicated by the dotted curved line. The artifact in this case is on the side of the film away from the reader. The two short bars, B and C (outlined in ink), are areas of removed emulsion on the artifact side. The long bar A represents removal of emulsion on the side away from the

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Fig. 1. Emulsion removed from a properly processed film.

artifact. It will be noticed that removal of emulsion in B and C to the right of the dotted line causes no change in appearance because in the region of the artifact there has been little or no darkening of the emulsion. Removal of emulsion in B and C to the left of the dotted line causes definite lightening of these areas compared to the surrounding area because here the emulsion has been darkened by normal development. The portion of A to the right of the dotted line shows almost completely white because the darkened emulsion on the front has been removed and the emulsion on the back has not been darkened due to the artifact. The portion of A to the left of the dotted line shows the same characteristics as B and C to the left of the dotted line, that is, some lightening because of removal of darkened emulsion on one side and the presence of normally darkened emulsion on the opposite side.

SUMMARY

A method is described for detecting the contact type of film artifacts when these are too small or too indistinct to produce a gloss readily recognizable by reflected light on the artifact side of the film.

A small "X" is scratched through the emulsion in the questionable area with one line of the "X" on one side and the other line on the opposite side. If a "contact" artifact is present, the line of the "X" on the side of the artifact will transmit definitely less light than the line on the opposite side.

Enlarged examples to show the principle of the method are presented.

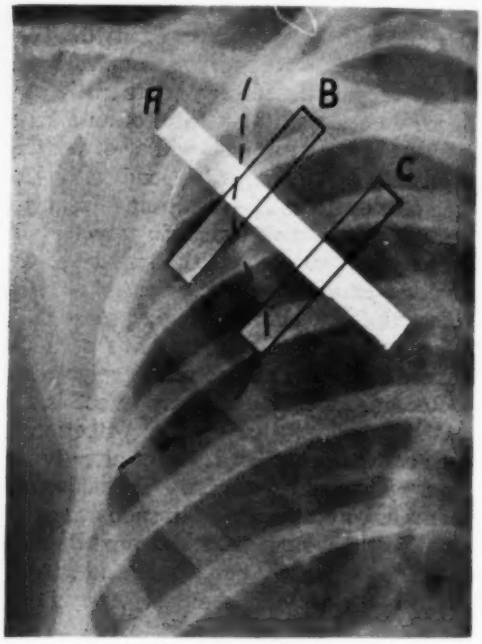

Fig. 2. Emulsion removed from a film showing a "contact" artifact. For explanation see text.

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SUMARIO

Método para Descubrir un Artefacto Dudoso en la Radiografía

Descríbese un método para descubrir artefactos de los debidos a contacto en las radiografías cuando son demasiado pequeños o imprecisos para producir un lustre fácil de reconocer al reflejar luz sobre el lado del artefacto en la película.

Se traza una "X" pequeña a través de la emulsión en la zona dudosa, con una línea de la "X" a un lado y la otra en el lado opuesto. Si hay presente un artefacto de los de "contacto," la línea de la "X" del lado del artefacto transmitirá decididamente menos luz que la línea del lado opuesto.

Recording Timer for Arteriography[1]

TOM M. FULLENLOVE, M.D.[2]

San Francisco, Calif.

THE TIMING OF films made rapidly during arteriography is difficult with a stop watch and, at best, an estimate is all that can be achieved. The timer herein described was developed to overcome this difficulty.

A simple electric clock motor was mounted in a case and a plastic disk was mounted on the shaft. Small lead numbers and serrated markings were placed around the edge of this disk, which projected just beyond the margin of the clock case. The placement of the numbers on the disk was made after timing its rotation. A handy switch was placed in the line cord of the clock to turn it on.

In use, after the patient has been positioned, the timer is so placed that its image will be on the film. The switch is located near the operator of the rapid film changer and is closed at the beginning of the injection of opaque material. Thereafter, the time after injection is recorded on each film as it is taken.

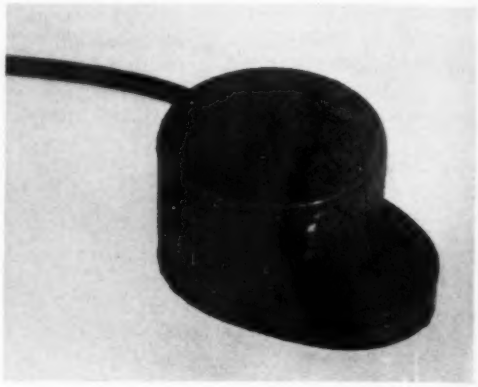


Fig. 1. Recording timer for arteriography.

This timer has been used for approximately a year and a half for over 200 arteriograms with satisfactory results.

NOTE: The author wishes to express his thanks to John Nordstrom for his technical assistance and advice.

450 Sutter St.
San Francisco 8, Calif.

SUMARIO

Cronorregistrador para la Arteriografía

El aparato descrito permite regular cronológicamente las radiografías tomadas en rápida sucesión para la arteriografía. Consta de un sencillo motor eléctrico de reloj montado en una caja y un disco de material plastico, montado de tal modo que el borde sobresalga ligeramente del borde de la caja del reloj. Después de graduar la rotación del disco, se colocaron pequeños números de plomo alrededor del borde del mismo y un conmutador en el cordón del reloj para echarlo a andar. Al emplearlo, después de colocar al enferms en posición, se coloca el registrador de manera que su imagen aparezca en la radiografía, registrándose así el tiempo tomado para cada exposición después de la inyección del medio opaco.

[1] From the Department of Radiology, Franklin Hospital, San Francisco, Calif. Accepted for publication in May 1952.

[2] Clinical Instructor in Radiology, University of California Medical School.

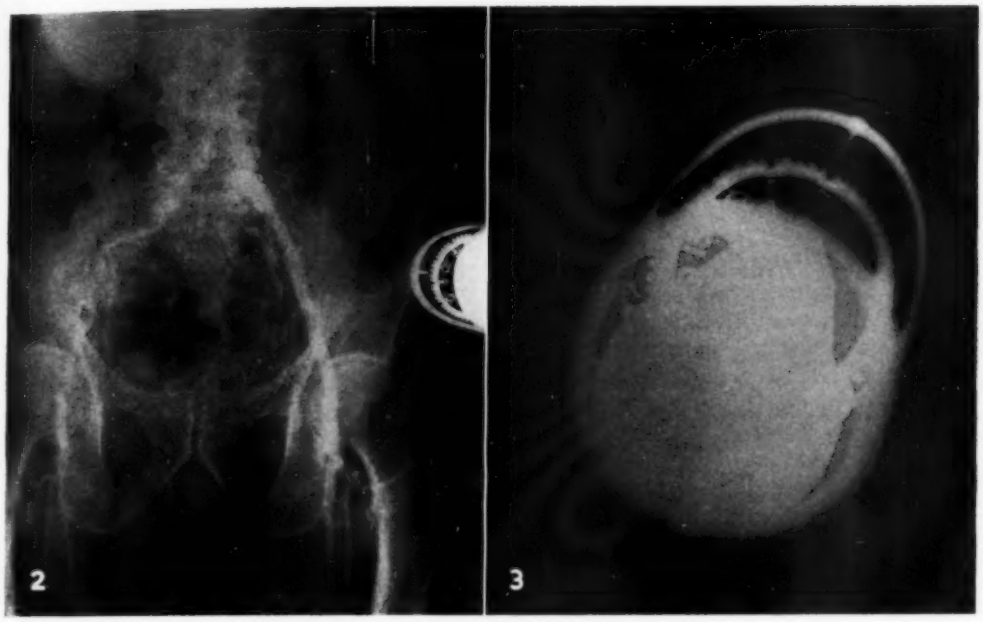


Fig. 2. Timer in use during aortography.
Fig. 3. Roentgenogram of timer, showing mechanism.

EDITORIAL

Radiology, a Medical Specialty[1]

Radiology is one of the youngest of the medical specialties, yet it wields an influence in organized medicine far in excess of its years. The diagnostic division occupies a cardinal place in almost all branches of medical science, for without a dependable roentgen diagnostic service accurate general medical diagnosis becomes exceedingly difficult and often impossible.

A specialty has as its major purpose the better accomplishment of certain functions than is possible where the field of endeavor is less limited. If there be need for the specialty under consideration and if the services entailed are available, from the economic standpoint, to the majority of those requiring them, success is assured. That the specialty of Radiology fills a great need is attested by its growth and the dependence placed upon the radiologist by his fellow physicians.

The development of the science of Radiology is of interest. We are all familiar with the history of the discovery of what William Conrad Roentgen, a physicist, termed the x-ray, a hitherto unknown type of ray later to be known as the roentgen ray. His investigations were so complete that little has been added to our knowledge of the characteristics of this ray since he announced his major findings and conclusions before the Wurzburg Physical Medical Society in 1895.

It at once became evident, especially to the medical profession, that here was a tool which would profoundly influence diagnosis. Somewhat later it was obvious that the influence on some forms of medical treatment would also be marked.

The evolution of specialization in the practice of medicine is usually gradual, but in Radiology we have an example of a specialty that burst into full flower almost immediately following Roentgen's initial announcement. In *The Science of Radiology*, edited by Otto Glasser of the Cleveland Clinic Foundation, there appears under the heading "Early Roentgen Literature" the statement that "before Roentgen's announcements were one year old three small books on Radiology had been published in America." The three were: *Roentgen Rays and the Phenomena of the Anode and Cathode*, by Edward P. Thompson, M.E.E., of New York; *The X Ray or Photography of the Invisible*, by William J. Morton, in collaboration with Edwin W. Hammer, Electrical Engineer; *The ABC of X Rays*, by William H. Meadowcroft of New York. The writer is fortunate in owning copies of the first two of the three.

Because of its bearing on the development of the specialty of Radiology, the book by Morton deserves special consideration. The publisher's note opens with this statement: "The world-wide interest that has been taken in Prof. Roentgen's discovery of the marvellous properties of the X Ray prompted the publishers of this work to call on Dr. William J. Morton of New York, who had already been acknowledged the best X Ray expert in the United States, and urge him to write the result of his investigations with the X Ray for the benefit of the many who desired reliable information on this scientific discovery."

These words might be set down to the over-enthusiasm of the publisher and be

[1] Presidential Address, delivered at the Thirty-eighth Annual Meeting of the Radiological Society of North America, Cincinnati, Ohio, Dec. 7–12, 1952.

deemed of little importance were it not that Glasser says, in speaking of Morton's work: "A review of his career from January to July 1896 justifies the statement of his publishers."

The authors' preface, dated Sept. 1, 1896, opens as follows:

"There are some discoveries of a purely scientific nature that appeal only to a limited class, while others broadly affect the life and happiness of the human race and thus become of universal importance. The discovery of Prof. Roentgen is unique in that it interests alike the scientific and nonscientific intelligent minds of all countries. To the world of science new problems as to the constitution of matter and the innermost secrets of electricity are suggested, while to the race at large is opened up a new means of diagnosis and relief of suffering and disease in the field of surgery. No wonder, then, that interest in this subject is universal."

The scope of Morton's early investigations and work, and his recognition of the far-reaching possibilities and effects of this new branch of science are remarkable. He is credited with doing the first dental radiography in America and he read a paper on this subject before the New York Odontological Society on April 24, 1896. He anticipated photofluoroscopy, which only now is becoming practical. "The fact is generally known," he wrote, "that the camera will see more than the human eye and this has led to direct photography, by means of the camera, of shadows thrown upon a fluorescent screen." "Obviously," he continues, "the pictures thrown upon the screen in a darkened room as just described may be photographed, and to this process has been given the name of photofluoroscopy. The resulting picture thus taken has more strength and detail than as viewed by the eye."

In the chapter dealing with the "Surgical Value of the X Ray," this is said: "Great as is the interest that has been excited by the X Ray in the scientific laboratories of the world, among electrical engineers, photographers, students and amateurs, still greater is its interest to the physician and surgeon, for in its application to surgery lies its highest field of usefulness to humanity. The physician has ever been on the alert to explore the mysteries of the human body, and to the already familiar methods of exploration such as the ophthalmoscope, stethoscope, cystoscope, the percussion hammer and the probe, is now added the revelation of the X Ray.

"Even as yet, in the undeveloped stage of Professor Roentgen's discovery, there can be little doubt that no more valuable means of diagnosis has ever been afforded to the science and art of medicine."

In a chapter headed "Medico-Legal," Morton says: "A very important application of the X Ray will be in connection with expert testimony in the courts. Court records contain numerous cases in which the X Ray would have been of great service. Already it has been used for this purpose."

Concerning possible therapeutic applications, he writes: "In favor of an influence of the X Ray upon tissue is the experience of the experimenter that after viewing a very powerful X Ray continuously through a fluoroscope the eyes are frequently affected painfully.

"Inflammation of the eyelids, upper lips and of the skin of the face generally, somewhat of the nature of sunburn, has been recorded by more than one experimenter as the result of exposure to the X Ray."

In conclusion, Morton anticipates many of the present-day industrial applications of the x-ray: "Flaws and weldings may be discovered in metals; investigation as to the amount of metal in different ores may be made, and it will interest dealers in diamonds to know that the X Ray positively distinguishes between the true diamond and the paste imitation."

Not only have the predictions of Morton concerning the future important place of Radiology in medical science been realized, but its scope and value in medical diagnosis and treatment now far surpass anything dreamed of by him. Our field of endeavor

will continue to expand and our contributions to increase if we, as specialists in Radiology, never lose sight of our major function, that of the physician and true consultant, who assumes responsibility in attempting to arrive at a correct diagnosis, who accepts responsibility for his share in conclusions drawn, who is ever considerate, cooperative, and ready to work with and to aid his associates, particularly the referring physician. Upon the radiation therapist rests the added burden of proper and intelligent direction of the patient's treatment.

A danger to our specialty in some quarters is that in much of the work there is no personal contact between the radiologist and his patient. In such instances, it is no wonder that the patient does not distinguish between the physician and technician, and that he has no appreciation of the important functions of the physician radiologist in a properly executed x-ray examination, or in intelligently administered radiation therapy. This need not be, for personal contact requires only a little more time, only a little more work, with returns far in excess of the added effort, not only in a better physician-patient relationship but in increased diagnostic accuracy and better directed and administered radiation therapy. Some may say: "I am too busy to take time for such personal contact." This is no answer. We have no right to accept responsibility for work when we are unable to give it adequate coverage, too busy to perform our duties properly and, in each case, to put forth our best efforts. This applies to the direction of radiation departments in hospitals both large and small, as well as to work with individual patients.

To the younger men in our ranks, may I say, you have entered a specialty which, although only slightly more than fifty years of age, already occupies an enviable place among the various fields of medicine. We know that you will spare no effort in insuring that its growth and influence continue to increase. Never fail to give to the work in hand your best efforts and to your patients the highest quality of care of which you are capable. You can be forgiven for an error made when you have done so, but you cannot be forgiven for carelessness and neglect, for the health and at times the life of the patient may be at stake.

JOSEPH C. BELL, M.D.

Editorial Staff Changes

It is with deep regret that the Publication Committee and the Editor have accepted the resignation of Dr. John D. Camp as an associate editor of RADIOLOGY. His wise counsel and help have been of inestimable value during the many years that he has served in that capacity. To him go the sincere personal appreciation of the Editor, whose hands he has so ably upheld, and the good wishes of his fellow radiologists, who have profited greatly by his association with RADIOLOGY.

At the same time it is a pleasure to announce the appointment of Dr. Leo G. Rigler as an associate editor. Dr. Rigler has a record of long and faithful service as a member of the Publication Committee of the Radiological Society of North America and is thoroughly conversant with the many problems involved in issuing a journal which will meet the standards set by the Society. He has, besides, a distin. guished teaching and clinical background. He is Professor of Radiology in the University of Minnesota and Chief of the Department of Radiology in that institution and in the Minneapolis General Hospital. He is a senior consultant to the Veterans Administration Hospital of Minneapolis and consultant to the U. S. Public Health Service, to the Armed Forces Institute of Pathology, and to the Minnesota State Department of Institutions.

Dr. Robert P. Barden, of the University of Pennsylvania, takes Dr. Rigler's place on the Publication Committee.

ANNOUNCEMENTS AND BOOK REVIEWS

AMERICAN COLLEGE OF RADIOLOGY

At the annual meeting of the American College of Radiology, in February, Dr. John D. Camp, of the Good Samaritan Hospital, Los Angeles, was elected President; Dr. Fredrick W. O'Brien of Boston, Vice-President; Dr. Earl E. Barth of Chicago, Treasurer. Dr. Ira H. Lockwood of Kansas City, Mo., was made Chairman of the Board of Chancellors. Newly elected members of that Board are Dr. Earl R. Miller of San Francisco, Dr. Thomas B. Bond of Fort Worth, Dr. Axel N. Arneson of St. Louis, and Dr. Joseph C. Bell of Louisville. Dr. Joshua C. Dickinson of Tampa was re-elected a Chancellor.

GREATER MIAMI RADIOLOGICAL SOCIETY

At the January meeting of the Greater Miami Radiological Society the following officers were elected: President, Dr. Theodore M. Berman; Vice-President, Dr. David Kirsh; Secretary-Treasurer, Dr. E. Hampton Bryson. The organization meets at different hospitals in the area on the third Wednesday of each month.

KENTUCKY RADIOLOGICAL SOCIETY

At the January meeting of the Kentucky Radiological Society, the following were elected officers for the coming year: Jesshill Love, M.D., President; H. L. Townsend, M.D., Vice-President; Everett L. Pirkey, M.D., Louisville General Hospital, Secretary-Treasurer; Sydney E. Johnson, M.D., Councilor to the American College of Radiology.

WESTCHESTER RADIOLOGICAL SOCIETY

The newly elected officers of the Westchester (New York) Radiological Society are Dr. Anthony Debbie, of Valhalla, President; Dr. Clifford C. Baker, Harwood Building, Scarsdale, Secretary; Dr. Fred H. Lutze, New Rochelle, Treasurer.

RADIATION RESEARCH SOCIETY

The annual meeting of the Radiation Research Society will be held at the State University of Iowa, Iowa City, on June 22–24, 1953. The Society will be the guest of the University and all meetings will be held on the campus. The program will include two symposia: one on "The Effects of Radiation on Aqueous Solutions, with E. S. G. Barron, Edwin J. Hart, Warren Garrison, J. L. Magee, and A. O. Allen as speakers; the second on "Physical Measurements for Radiobiology" with companion talks by Ugo Fano, Burton J. Moyer, G. Failla, L. D. Marinelli, and Payne S. Harris. On Monday night, June 22, a lecture by Dr. L. W. Alvarez on meson physics has been tentatively scheduled. On Tuesday night, June 23, Dr. L. H. Gray of Hammersmith Hospital, London, will speak on a topic to be announced. Dr. Gray's lecture is sponsored by the Iowa Branch of the American Cancer Society.

Those desiring to report original research in radiation effects or interested in attending or desiring additional information should contact the Secretary of the Society, Dr. A. Edelmann, Biology Department, Brookhaven National Laboratory, Upton, L. I., N. Y.

JOSEPH FREEDMAN LECTURES UNIVERSITY OF CINCINNATI

On Saturday and Sunday, May 2 and 3, 1953, Dr. Philip J. Hodes, Professor of Radiology, Medical School of the University of Pennsylvania, and Professor of Radiology, Graduate School of Medicine, University of Pennsylvania, will deliver the fifth annual Joseph Freedman Lectures in Diagnostic Roentgenology at the University of Cincinnati College of Medicine. Roentgenologists desiring to attend are requested to write Dr. Benjamin Felson, X-ray Department, Cincinnati General Hospital, for further details.

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

An advanced course in autoradiography and three basic courses in radioisotope technics are offered during the spring and summer of 1953 by the Special Training Division of the Oak Ridge Institute of Nuclear Studies. The autoradiography course will be held June 15–25, and the basic courses, of four weeks duration, will begin on June 8, July 6, and August 10.

Application forms and additional information may be obtained from the Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

COURSE IN MOVING FIELD THERAPY

The Medical University Clinic in Erlangen (Germany) announces a postgraduate course covering all forms of moving field therapy, to be held Aug. 3–8, 1953, following the International Congress of Radiology in Copenhagen. The course is planned especially for those who are not conversant with the German language, and reports will be presented in English and Spanish only. Treatment schemes and actual treatment of patients will be demonstrated. The fee is DM 75.—Further details may be obtained by addressing Sekretariat des Fortbildungskurses für Bewegungsbestrahlung, Medical University Clinic, Krankenhausstr. 6, Erlangen, West-Deutschland.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ANNUAL REVIEW OF NUCLEAR SCIENCE, Volume 2, Edited by J. G. BECKERLEY. A volume of 430 pages, with numerous charts and tables. Published by Annual Reviews, Inc., in co-operation with the National Research Council of the National Academy of Sciences. On sale by Annual Reviews, Inc., Stanford, Calif. Price $6.00.

LA TOMOGRAPHIE DE LA BASE DU CRANE EN NEUROCHIRURGIE ET NEURO-OPHTALMOLOGIE. By H. FISCHGOLD, Électro-radiologiste des Hôpitaux de Paris, M. DAVID, Neuro-chirurgien des Hôpitaux de Paris, and P. BRÉGEAT, Ophtalmologiste des Hôpitaux de Paris. A monograph of 138 pages, with 107 illustrations. Published by Masson et Cie, Paris, 1952. Price 1,600 fr.

LE PNEUMO-RÉTRO-PÉRITONINE. By L. DE GENNES, J.-P. MAY, AND J. HÉLIE. A monograph of 107 pages, with 50 illustrations. Published by Masson et Cie, Paris, 1952. Price 1,200 fr.

Book Reviews

GASTROINTESTINAL X-RAY DIAGNOSIS. By MAX RITVO, M.D., Assistant Professor of Radiology, Harvard Medical School; Instructor in Radiology, Tufts Medical School; Director, Department of Radiology, Boston City Hospital; Associate in Radiology, Beth Israel Hospital, Boston, Mass., and I. A. SHAUFFER, M.D., Instructor in Radiology, Harvard Medical School; Instructor in Radiology, Tufts Medical School; Visiting Radiologist, Boston City Hospital. Published by Lea & Febiger, Philadelphia, 1952. A volume of 838 pages with 470 illustrations (2 in color). Price $20.00.

In this new text on *Gastrointestinal X-Ray Diagnosis*, the authors have covered completely and authoritatively the entire digestive system, including in addition to the gastrointestinal tract, the gallbladder, pancreas, spleen, mesentery, omentum, peritoneum, and other abdominal structures. The subject matter is presented in considerable detail, but in a clear concise manner that makes for easy reading. Clinical material is included to facilitate the understanding of the subject, and in many instances a pathological description gives valuable information concerning the lesion under discussion.

The text comprises 838 pages with 470 well chosen illustrations, two of which are in color. A comprehensive bibliography is appended to each chapter. A good index makes for ready reference. The book is attractively bound and well printed. It will be useful both to the radiologist and to others interested in the digestive tract.

DISEASES OF THE CHEST. By T. ROYLE DAWBER, A.B., M.D.,F.A.C.P., Senior Surgeon, U.S.P.H.S.; Chief of Heart Disease Epidemiology Study, National Heart Institute; Assistant in Medicine, Harvard Medical School, and LLOYD E. HAWES, A.B., M.D., D.A.B.R., Radiologist at Faulkner Hospital; Consultant at U.S.P.H.S. Hospital, Boston. A volume of 440 pages, with 216 roentgenograms. Published by the Williams & Wilkins Co., Baltimore 2, Md., 1952. Price $10.00.

The authors, realizing the complexity of the study of chest diseases, have combined their roentgenologic and clinical talents to produce this book. In the Introduction they state: "It behooves the physician interested in chest disease to be familiar with both the clinical aspects and roentgenological features of these diseases." This theme is maintained throughout the book. In the presentation of each disease process the history, roentgenological appearance, physical findings, bronchoscopic findings, and laboratory studies are given.

Following the discussion of the normal chest and the various methods of examination used in diagnosis, are chapters devoted to the various anatomical divisions. These include the chest wall, diaphragm, pleura, mediastinum, trachea and bronchi, heart, and lungs. A full chapter is devoted to pulmonary tuberculosis.

The arrangement within each chapter facilitates the study of differential diagnosis. A large number of representative films are reproduced. The book is easy to read, since the authors have not intended it to be an exhaustive reference work and have not filled it with minutiae. For this reason it is recommended more for reading as a textbook than for use as a work of reference.

X-RAY DIAGNOSIS OF CHEST DISEASES. By COLEMAN B. RABIN, M.D., Assistant Clinical Professor of Medicine, College of Physicians and Surgeons, Columbia University; Associate Physician for Chest Diseases and Associate Radiologist, Mt. Sinai Hospital, New York; Consulting Physician for Chest Diseases, Beth El Hospital; Senior Consultant for Chest Diseases, Veterans Administration. A volume of 146 pages, with 288 illustrations. Reprinted from Golden's Looseleaf Diagnostic Roentgenology, with the same page numbers used in that text. Published by Williams & Wilkins Co., Baltimore, Md., 1952. Price $12.00.

The publishers have reprinted from Golden's Looseleaf Diagnostic Roentgenology the section on chest diseases by Dr. Coleman B. Rabin, in a bound volume of convenient size, for those whose

special interests lie in this direction. The work is divided into four parts. Part I is devoted largely to technical considerations, anatomical studies and fluoroscopy. Part II covers general roentgen pathology, Part III regional roentgen pathology, and Part IV differential diagnosis. The volume is nicely bound. A comprehensive bibliography follows the text, and an adequate index is included.

The reissue of selected chapters from the original two-volume looseleaf work edited by Golden is an excellent idea. In this instance it offers a valuable addition to the library of those primarily concerned with diseases of the chest.

VISUAL ANATOMY: THORAX AND ABDOMEN. By SYDNEY M. FRIEDMAN, M.D., Ph.D., Professor of Anatomy, University of British Columbia, Vancouver, Canada; Formerly, Associate Professor of Anatomy, McGill University, Montreal, Canada. A volume of 204 pages, with 91 illustrations. Published by Charles C Thomas, Springfield, Ill., 1952. Price $10.50.

This book conforms in objective, presentation, and format to the author's recently published "Visual Anatomy: Head and Neck." In keeping with the title, its primary emphasis is on illustrations. The book may be described as a condensed atlas-text, the number of illustrations being small as compared with the conventional atlases and the text being largely devoted to explanations of the figures. Illustrations naturally represent topics selected by the author as most deserving of attention, and each portrays only salient features of the organs and regions. Shorn of unnecessary detail, the figures have the virtues of a teacher's blackboard drawings, though of course the quality of draftsmanship could rarely be matched by teaching anatomists. Each figure occupies a right-hand page, and the explanatory text is conveniently placed on the facing page. The sequence of illustrations is planned with the skeletal framework as the point of reference. To choose the thorax as an example, the main headings are: framework, mediastinum, lungs, surface anatomy, autonomic innervation. Then, under "the framework," the nine figures in order are: thoracic vertebrae, ribs, ribs and sternum, diaphragm, costal muscles, nerve supply, arterial supply, venous drainage, sympathetic nervous system. This "visual anatomy" should be useful to students for preview of any subject that it covers, in preparation for the more detailed approach in a standard text and in dissection. It should prove helpful, also, for review.

A STUDENTS' RADIOLOGICAL MATHEMATICS. ELEMENTARY MATHEMATICS APPLIED TO MEDICAL RADIOLOGY. By L. A. W. KEMP, B.Sc., F. Inst. P., Physicist to the London Hospital, formerly Lecturer in Physics at the Polytechnic, London. A volume of 316 pages, with 128 figures. Published by Blackwell Scientific Publications Ltd., Oxford, England, by Charles C Thomas, Springfield, Ill., and by the Ryerson Press, Toronto, Canada, 1952. Price $5.00.

In *A Students' Radiological Mathematics*, the avowed purpose of the author is to develop the subject of mathematics and integrate it with the problems that are met in the field of radiology. In the arrangement of his material he has followed the traditional separation of mathematics into sections on algebra, geometry, trigonometry, etc., through calculus. The chapter on nomography is of particular interest and of all the sections lends itself best to practical application.

The book has been written for the individual with little or no mathematical background and, considering the size of the volume, the author has performed a remarkably complete development of the subject, though it is doubtful if such a student would progress beyond the first chapter. However, the work is an excellent review for those who have not been exposed to mathematics or physics for a number of years, and it will be a useful addition to the radiologist's library

The most valuable and instructive portions of the book are the exercises and illustrative problems dealing with the practical applications of mathematics to the physical phenomena met with in diagnostic and therapeutic radiology.

RADIOLOGIC DIAGNOSIS OF THE LOWER URINARY TRACT. By DONALD E. BEARD, M.D., Assistant in Urology, Emory University School of Medicine; Visiting Urologist, Grady Memorial Hospital, Atlanta, Georgia; WILLIAM E. GOODYEAR, M.D., Assistant in Urology, Emory University School of Medicine; Visiting Urologist, Grady Memorial Hospital, Atlanta, Georgia; H. STEPHEN WEENS, M.D., Professor and Chairman, Department of Radiology, Emory University School of Medicine; Radiologist, Grady Memorial Hospital and Emory University Hospital, Atlanta, Georgia. A volume of 144 pages with 280 illustrations. Published by Charles C Thomas, Springfield, Ill., 1952. Price $6.50.

This book covers a branch of diagnostic roentgenology which has been somewhat overlooked, or at least little emphasized, in the past. The authors aim to demonstrate the value of urethrography, urethrocystography, and cystography in various pathological conditions of the lower urinary tract. The advantages of such studies over other methods of examination in some of these conditions are discussed.

Following an introductory chapter which includes brief descriptions of the anatomy of the bladder and urethra, the technic of the procedures for examination, and their indications, the authors take up in turn the normal urethrogram, the anterior urethra, the membranous urethra, the posterior urethra, and

the bladder. Their concluding chapter discusses urethrography and cystography in children.

The major part of the book follows the atlas technic, with short pathologic accounts of the conditions under discussion supported by numerous roentgen reproductions accompanied frequently by drawings which clarify the findings.

The discussions are concise and the roentgenographic reproductions are profuse and excellent. Each illustration has an explanatory caption. The book is complete in its scope and is a useful guide for both the radiologist and the urologist.

GRUNDLAGEN DER RÖNTGENDIAGNOSTIK UND RÖNTGENTHERAPIE. By PROF. DR. G. SCHULTE, Recklinghausen, AND Dr. F. KUHLMANN, Essen. Third Edition. A volume of 298 pages with 331 illustrations. Published by Georg Thieme, Stuttgart, 1952. Agents for U. S. A. Grune & Stratton, Inc., New York, N. Y. Price DM 29.70.

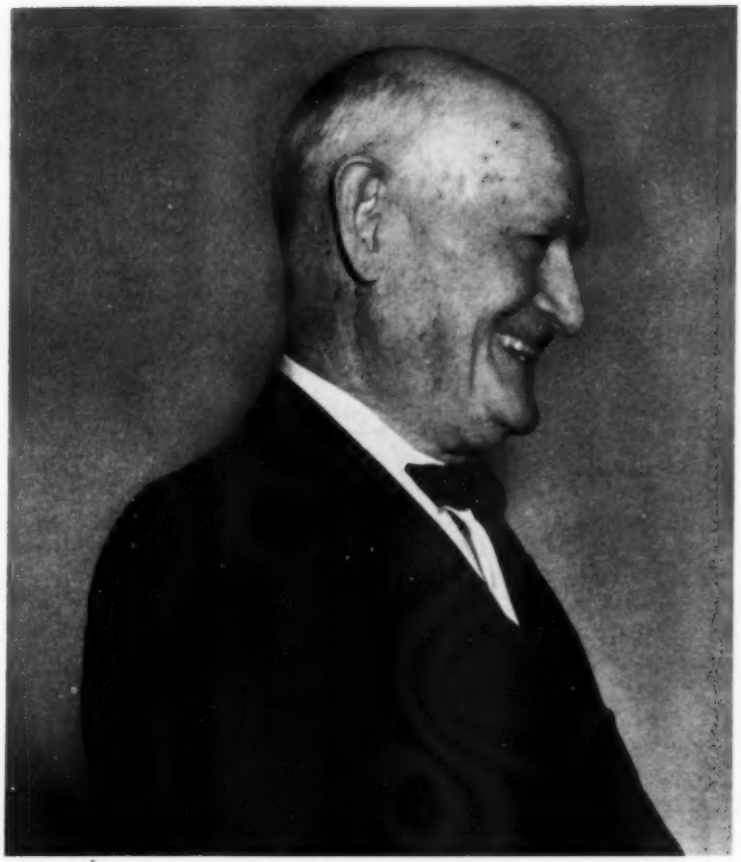
According to the introduction, this text is intended for beginning students and as a ready reference work for hospital physicians and practitioners. On this basis, it would not be expected to show unusual profundity or attention to minute detail. Even by such lenient standards, however, it appears to be somewhat superficial. Thirty-one pages are devoted to physics, technic, dosage, and allied subjects, which seems sufficient for a book of this type. But radiation injuries are covered by one short page, surely far too little for so vital a subject. The danger of unrestricted fluoroscopy goes unmentioned, although this is probably the most important single warning for students. Most of the diseases of the bones and joints are named, but their discussion is so condensed as to be lacking in clarity, especially as regards differential diagnosis.

In the section on the head, there are some nice diagrams of the ventricular system for encephalography, but cerebral arteriography is dismissed with three sentences. In the chest section considerable attention is given to the segmental arrangement of the lungs, and the discussion of pulmonary disease is the best in the book. The heart is covered in seventeen pages, but angiocardiography rates only about half a page of general consideration. The two and a half pages of text devoted to cardiac malformations do not indicate in any specific way the findings on the angiograms, nor is the information given such as to make readily understandable to the beginner either the variations to be anticipated or the reasons for them. This important subject is very poorly covered indeed. Gastrointestinal and urological diagnosis seem to be adequately if briefly treated.

The therapy section is so extremely condensed as to be quite valueless. For example, the discussion of the treatment of thyrotoxicosis is given a little less than half a page under x-ray therapy. No mention is made of the use of radioactive isotopes in the treatment of this condition either here or in the later section on radium and radioactive products. Gynecological tumors and mammary carcinoma get a little less than half a page each, while lung carcinoma and mediastinal tumors receive only an inch of text apiece. The section on radium and radioactive substances concerns itself mostly with radium, radon, and the thorium degradation products and is quite out of date. Even here gynecological carcinoma gets only two inches of text. There is no discussion of the artificially radioactive substances.

The illustrations and anatomical drawings are excellent, although the roentgenograms are reproduced in positive. They are the high light of the book.

This book is too superficial to accomplish its object, even as a text for beginners. Considering the evidently large amount of work invested in the volume, it would be desirable for the authors to put in a little more for the sake of completeness and lucidity.



Arthur C. Christie, M.D.

On Dec. 20, 1952, friends of Dr. Arthur Carlisle Christie gathered at a dinner in the Shoreham Hotel, Washington, D. C., honoring his half century of service in the field of medicine. Honors are not new to Dr. Christie. He has had a distinguished career in medicine and more particularly in the specialty of radiology.

He was born in West Sunbury, Penna., in 1879, the son of a country doctor, and he himself began his practice in a large rural community following his graduation from the Cleveland College of Physicians and Surgeons. In 1906 he joined the Army Medical Corps and at once became interested in radiology, then only beginning to be recognized as a specialty. During World War I he was chief of the Division of Roentgenology of the Army Medical Corps and following his return to civilian practice he was soon recognized as one of the outstanding representatives of American radiology.

In addition to his private practice in association with the late Dr. Groover, Dr. Christie has found time for a large number of activities in various fields. He was professor of radiology at Georgetown University School of Medicine and at George Washington University and a consultant of the National Cancer Institute. He was President of the Fifth International Congress of Radiology in 1937. He has served also as President of the American Board of Radiology, the American College of Radiology, and the American Roentgen Ray Society, and as Chairman of the Committee on Radiology of the American Research Council. His contributions to the literature are extensive, and from 1924 to 1929 he was editor of the *American Journal of Roentgenology and Radium Therapy*. In February 1953 Dr. Christie was awarded the Gold Medal of the American College of Radiology.

RADIOLOGY is happy to join with Dr. Christie's other friends in paying tribute to his notable achievements.

Edward H. Skinner, M.D.

IN MEMORIAM

Edward Holman Skinner, M.D.

1881–1953

The medical profession lost a dynamic personality in the death of Dr. Edward H. Skinner on Jan. 11. Dr. Skinner was born in Milwaukee, Wis., on Jan. 7, 1881. He was graduated from St. Louis University in 1904 and was in Europe in 1909–10 carrying out studies in radiology, to the practice of which he was to devote the years that followed. During World War I he served with the rank of Lt. Colonel and was Associate Consultant in X-Ray for the American Expeditionary Forces.

Dr. Skinner's entire life was one of activity and organization. In 1911 he was a leader in the efforts which resulted in the establishment of the present library of the Jackson County (Kansas) Medical Society. Later he became President of the Society and he continued to be Chairman of the Library Committee until his death. In 1923 he founded the Kansas City Southwest Clinical Society; he was its first president and served continuously as the editor of its journal. In 1932-34 he was a director of the American Society for the Control of Cancer, and was president of the Health Council of Kansas City, Missouri, in 1933.

Dr. Skinner's talent for organization and his high-voltage interests led him to important committee assignments in national medical organizations. A strong believer in individual initiative, he worked to protect the profession from any encroachment by government.

In the later years of his life, Dr. Skinner spent much time assembling historical material, books, and objects having to do with the discovery and medical uses of roentgen rays, radium, and atomic energy. This material he presented to the library of the Kansas University Medical Center, where he was a lecturer in radiology and in the history of medicine.

Dr. Skinner was the recipient of numerous national honors. He served as President of the American Roentgen Ray Society in 1928, the American Radium Society in 1937, and the American College of Radiology in 1946-47. He was a member of the American Board of Radiology and recipient of the Janeway Award in 1941 from the American Radium Society. The gold medal of the American College of Radiology was awarded to him posthumously on Feb. 6, 1953.

The medical profession of the nation and Kansas City, and the specialty of Radiology, have lost a man of the finest talents, given freely for the good of humanity.

IRA H. LOCKWOOD, M.D.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, John E. Wirth, M.D., 635 Herkimer St., Pasadena 1, Calif.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, Barton R. Young, M.D., Germantown Hospital, Philadelphia 44, Penna.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, Paul C. Hodges, M.D., 950 East 59th St., Chicago 37.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. A. Meadows, Jr., M.D., Medical Arts Bldg., Birmingham 5.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 15 East Monroe, Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary*, Fred Hames, M.D., Pine Bluff. Meets every three months and at meeting of State Medical Society.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, Calvin L. Stewart, M.D., 2330 First Ave., San Diego.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Joseph F. Linsman, M.D., 436 N. Roxbury Dr., Beverly Hills. Meets monthly, second Wednesday, Los Angeles County Medical Association Bldg.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY. *Secretary*, Richard C. Ripple, M.D., 1215 28th St., Sacramento. Meets at dinner last Monday of September, November, January, March, and May.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, C. W. Bruner, M.D., 2456 Fourth Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary*, I. J. Miller, M.D., 2680 Ocean Ave., San Francisco 27. Meets quarterly, at the University Club.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Ford Shepherd, M.D., 526 Soquel Ave., Santa Cruz. Meets monthly, second Wednesday.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, Wm. W. Saunders, M.D., VA Hospital, San Francisco 21. Meets third Thursday at 7:45, Lane Hall, Stanford University Hospital.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Wm. S. Curtis, M.D., 304 Republic Bldg., Denver. Meets monthly, third Friday, at University of Colorado Medical Center or Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, William A. Goodrich, M.D., 85 Jefferson St., Hartford 14. Meets bimonthly, second Wednesday.

CONNECTICUT VALLEY RADIOLOGICAL SOCIETY. *Secretary*, B. Bruce Alicandri, M.D., 20 Maple St., Springfield, Mass. Meets second Friday of October and April.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary*, U. V. Wilcox, M.D., 915 19th St., N.W., Washington 6. Meets third Thursday, January, March, May, and October, at 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, A. Judson Graves, M.D., 2002 Park St., Jacksonville. Meets in April and in November.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary*, E. Hampton Bryson, M.D., 273 Alhambra Circle, Coral Gables. Meets monthly, third Wednesday, 8:00 P.M., Veterans Administration Bldg., Miami.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Albert A. Rayle, Jr., M.D., 478 Peachtree St. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert M. Tankesley, M.D., 218 Doctors Bldg., Atlanta. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital. Augusta.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary*, Col. Alexander O. Haff, Tripler Army Hospital, Honolulu. Meets monthly on the third Friday, at Tripler Army Hospital.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary*, Elbert K. Lewis, M.D., 6337 S. Harvard Ave., Chicago 21. Meets at the University Club, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stephen L. Casper, M.D., Physicians and Surgeons Clinic, Quincy.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, George E. Irwin, Jr., M.D., 427 N. Main St., Bloomington.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, John A. Robb, M.D., 23 East Ohio St., Indianapolis. Annual meeting in May.

Iowa

IOWA X-RAY CLUB. *Secretary*, James McMillen, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and holds a scientific session in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary*, Willis L. Beller, M.D., 700 Kansas Ave., Topeka. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary*, Everett L. Pirkey, M.D., Louisville General Hospital. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Hugh Allan Smith, M.D., Eastern Maine General Hospital, Bangor. Meets three times a year—Spring, Summer, and Fall.

Maryland

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION. *Secretary-Treasurer*, H. Leonard Warres, M.D., 2337 Eutaw Place, Baltimore 17. Meets third Tuesday, September to May.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary*, James C. Cook, M.D., Harper Hospital, Detroit 1. Meets first Thursday, October to May, at Wayne County Medical Society club rooms.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary*, John R. Hodgson, M.D., The Mayo Clinic, Rochester. Meets in Spring and Fall.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John W. Evans, M.D., 117 N. President St., Jackson, Miss. Meets monthly, third Tuesday, at 6:30 P.M., at the Rotisserie Restaurant, Jackson.

Missouri

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Sidney Rubin, M.D., 410 Professional Bldg., Kansas City, Mo. Meets last Friday of each month.

ST. LOUIS SOCIETY OF RADIOLOGISTS. *Secretary*, Francis O. Trotter, Jr., M.D., 634 North Grand Blvd., St. Louis 3. Meets on fourth Wednesday, October to May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary*, Grant P. Raitt, M.D., 413 Medical Arts Bldg., Billings. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James F. Kelly, Jr. M.D., 816 Medical Arts Bldg., Omaha. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, Stanley M. Wyman, M.D., Massachusetts General Hospital, Boston 14. Meets monthly on third Friday, at the Harvard Club, Boston.

New Hampshire

NEW HAMPSHIRE ROENTGEN SOCIETY. *Secretary*, Albert C. Johnston, M.D., 127 Washington St., Keene.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Nicholas G. Demy, M.D., 912 Prospect Ave., Plainfield. Meets at Atlantic City at time of State Medical Society and midwinter in Elizabeth.

New York

BUFFALO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets second Monday, October to May.

CENTRAL NEW YORK ROENTGEN SOCIETY. *Secretary*, Dwight V. Needham, M.D., 608 E. Genesee St., Syracuse 2. Meets in January, May, October.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meets fourth Thursday, October to April (except December), at 8:45 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Joseph J. La Vine, M.D., 259 North Grand Avenue, Baldwin, N.Y. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, Harold W. Jacox, M.D., 622 W. 168th St., New York 32.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John F. Roach, M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April. Annual meeting in May or June.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, A. Gordon Ide, M.D., 277 Alexander St. Meets at Strong Memorial Hospital, 8:15 P.M., last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, Clifford C. Baker, M.D., Harwood Bldg., Scarsdale. Meets third Tuesday of January and October and at other times as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary*, Waldemar C. A. Sternbergh, M.D., 1400 Scott Ave., Charlotte 2. Meets in April and October.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, H. Milton Berg, M.D., Quain & Ramstad Clinic, Bismarck. Meets in the Spring with State Medical Association and in the Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Willis S. Peck, M.D., 1838 Parkwood Ave., Toledo 2. Meets with State Medical Association.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Riebel, M.D., 15 W. Goodale St., Columbus. Meets second Thursday, October, December, February, April, and June, 6:30 P.M., Columbus Athletic Club, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Mortimer Lubert, M.D., Heights Medical Center Bldg., Cleveland Heights 6. Meets at 6:45 P.M. on fourth Monday, October to April, inclusive.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Harry K. Hines, M.D., 2508 Auburn Ave., Cincinnati 19. Meets first Monday of each month, September to June, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary*, W. S. Koller, M.D., 60 Wyoming St., Dayton. Meets monthly, second Friday.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John R. Danstrom, M.D., Medical Arts Bldg., Oklahoma City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Richard Raines, M.D., Medical-Dental Bldg., Portland 5. Meets monthly, second Wednesday, October to June, at 8:00 P.M., University Club.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Sydney J. Hawley, M.D., 1320 Madison St., Seattle 4. Meets annually in May.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James M. Converse, M.D., 416 Pine St., Williamsport 8. Meets annually.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, George P. Keefer, M.D., American Oncologic Hospital, Philadelphia 4. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary-Treasurer*, Donald H. Rice, M.D., West Penn Hospital, Pittsburgh 24. Meets monthly, second Wednesday, at 6:30 P.M., October to May, at Webster Hall.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Maurice D. Frazer, M.D., 1037 Stuart Bldg., Lincoln, Nebr.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*. Henry E. Plenge, M.D., Spartanburg General Hospital, Spartanburg. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

Tennessee

MEMPHIS ROENTGEN CLUB. *Secretary*, Harvey Thompson, M.D., 899 Madison Ave. Meets first Monday of each month at John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frère, M.D., Newell Hospital, Chattanooga 2. Meets annually with State Medical Society in April.

Texas

DALLAS-FORT WORTH ROENTGEN STUDY CLUB. *Secretary*, Claude Williams, M.D., Fort Worth. Meets monthly, third Monday, in Dallas odd months, Fort Worth even months.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Frank M. Windrow, M.D., 1205 Hermann Professional Bldg.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Building, San Antonio 5, Texas. Meets at Brook Army Medical Center, the first Monday of each month.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 650 Fifth Ave., Fort Worth. Next meeting Jan. 23–24, 1953, San Antonio.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Angus K. Wilson, M.D., 343 S. Main St., Salt Lake City 1. Meets third Wednesday, January, March, May, September, November.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, P. B. Parsons, M.D., 1308 Manteo St., Norfolk 7.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John N. Burkey, M.D., 555 Medical-Dental Bldg., Seattle. Meets fourth Monday, September through May, at College Club, Seattle.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Jerome L. Marks, M.D., 161 W. Wisconsin Ave., Milwaukee 1. Meets monthly on fourth Monday at the University Club

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D., 425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE. Meets first and third Thursday at 4 P.M., September to May, Service Memorial Institute.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, W. W. Moir, M.D., Sheboygan Memorial Hospital, Sheboygan.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Jean Bouchard, M.D. Assoc. Hon. Secretary-Treasurer, D. L. McRae, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 26, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTROLOGIE ET DE RADIOLOGIE MÉDICALES. *General Secretary*, Origène Dufresne, M.D., Institut du Radium, Montreal. Meets third Saturday each month.

CUBA

SOCIEDAD DE RADIOLOGÍA Y FISIOTERAPÍA DE CUBA. Offices in Hospital Mercedes, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA Y FISIOTERAPÍA. *General Secretary*, Dr. Dionisio Pérez Cosio, Marsella 11, Mexico, D.F. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

PUERTO RICO

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary*, Jesús Rivera Otero, M.D., Box 3542 Santurce, Puerto Rico.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

The Role of Radiology in the Diagnosis of Brain Tumors. Arthur B. Smith. South. M. J. **45:** 388–394, May 1952.

The characteristic changes produced by neoplasms of the brain in plain films, intracranial air studies, and in angiographic studies are summarized. Fifty per cent of expanding intracranial lesions produce sufficient changes on the plain film to localize them or arouse the examiner's suspicion. These changes in order of frequency are: (1) sellar erosions and deformities, (2) pineal displacement, (3) demineralization of the dorsum sellae, (4) calcification, (5) widened sutures, (6) increased digital markings, (7) sphenoidal fissure changes, (8) table changes (hyperostosis or erosions), (9) orbital bone changes, (10) enlarged internal auditory meatus, (11) petrous pyramid erosions, (12) choroid displacement, (13) displaced falx, (14) increased table vascularity.

The characteristic pneumographic and angiographic findings of tumors according to their location in the brain are presented as follows:

	Pneumographic	Angiographic
Frontal lobe	Anterior horn distorted. Ventricles shifted to opposite side from tumor	Localized stretching and displacement of anterior cerebral artery to opposite side
Temporal lobe	Unilateral ventricular collapse with contralateral hydrocephalus; depression or elevation of the inferior horn; displacement to opposite side from tumor	Elevation of the sylvian vessels
Parietal lobe	Collapse of the lateral ventricle involving chiefly the body; displacement to opposite side usually less than with temporal lobe tumors	Depression of sylvian vessels and pericallosal artery
Occipital lobe	Distortion of posterior and inferior horns and hydrocephalus of contralateral ventricle	Elevation and crowding of angular and posterior temporal arteries with terminal branches spread and distended
Third ventricle	Dilatation of lateral ventricles; partial to complete obliteration of third ventricle	None
Lateral ventricles	Filling defect characteristic of outline of tumor; dilatation of one or both ventricles	None
Basal ganglia and thalami	Dilatation of lateral ventricles; deformity of posterior wall of third ventricle; compression of the body of the lateral ventricle on the tumor side	Basal ganglia: forward and upward bulge of anterior cerebral artery. Thalamus: downward and posterior displacement of anterior choroidal artery
Suprasellar	Obliteration of cisterna chiasmatis; antero-inferior filling defect in third ventricle; filling defects in floor of anterior horns of lateral ventricles	Elevation of supraclinoid portion of internal carotid artery and displacement laterally; displacement of first segment of anterior cerebral artery upward and slightly laterally
Hypophysis	Dilatation of lateral ventricles; elevation and obliteration of third ventricle	Elevation and lateral displacement of parasellar portion of internal carotid artery
Subtentorial	Dilatation of the lateral and third ventricles without displacement; fourth ventricle may show filling defect or be obliterated	Distortion and displacement of cerebellar arteries (very little angiography has been done in this region)

Twelve roentgenograms.

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Occlusive Cerebrovascular Disease Simulating Brain Tumor. Angiographic Differentiation. Gordon L. Smiley. Arch. Neurol. & Psychiat. **67:** 633–640, May 1952.

Since occlusive states may be attended by ipsilateral cerebral edema of severe degree, producing pineal and ventricular shift, craniotomy is sometimes undertaken, and failure to find a neoplasm puzzles and embarrasses the sensitive neurosurgeon. Cerebral angiography has provided an accurate method for determination of the precise diagnosis in such problematic cases of vascular occlusion and/or attenuation. The method is of particular importance in those cases with ipsilateral edema in which the condition might be interpreted, ventriculographically, as brain tumor.

Angiography is at least as sensitive as ventriculography in revealing hemispheral shift, and it has the further advantage of providing important etiologic information. Angiographic evidence of high-grade or complete occlusion of the carotid artery or middle cerebral system is sufficient to explain hemispheral shift and is entirely compatible with it. Although spontaneous intracerebral hemorrhage may be associated with attenuation of cerebral vessels, actual occlusion is uncommon in hemorrhagic stroke. Occlusion of the carotid siphon or its major divisions may occur in connection with ruptured aneurysm involving these vessels and angiographic delineation of intracerebral clots may be rendered difficult, since displaced vessels are not demonstrated. Most of these clots are located in the temporal lobe, however, and since thrombus propagation distal to aneurysms commonly spares at least one trunk of the middle cerebral system, there is usually a patent channel revealing pathognomonic dislocation. Ruptured aneurysm of the anterior segment of the circle of Willis may induce occlusion of the ipsilateral anterior cerebral artery and may be the source of intrafrontal hemorrhage. Bilateral angiography should provide all the necessary information for differentiating these states, since the paired anterior cerebral arteries are symmetrically located in the mid-line. Moreover, in spite of distal thrombus propagation, aneurysms are usually demonstrated, and this clue alone should suggest the possibility of intracerebral hemorrhage. Extreme narrowing of the basilar portion of the carotid tree following spontaneous subarachnoid bleeding is presumed to represent spasm. This condition may persist for two to three weeks and should not be confused with intrinsic cerebroarterial disease.

Two cases are reported which illustrate graphically the contribution of angiography in suspected lesions of the cerebral hemisphere. Needless craniotomy may be

avoided, and certain cases in which the angiogram shows occlusion and severe hemispheral shift can be selected for decompression.

Five roentgenograms. DANIEL WILNER, M.D.
Atlantic City, N. J.

Cerebral Angiography in Children: An Anatomoclinical Evaluation. Jorge A. Picaza. J. Neurosurg. **9:** 235–244, May 1952.

This paper is an analysis of the results of cerebral angiography in a series of 50 cases of different neurologic conditions in children, verified by necropsy or operation.

Convulsions appeared during the performance of cerebral angiography in 3 cases, but all 3 patients had had convulsions for some time before angiography was performed. Two of them were injected with a 75 per cent solution of a contrast medium which was subsequently discarded in favor of a 35 per cent solution. Three patients had a cervical sympathetic paralysis which disappeared within a period of eight weeks. This was probably due to damage to the sympathetic chain during the dissection of the carotid artery in the neck. In 2 cases there was a moderate polypnea with subcutaneous crepitation in the neck and evidence of pneumomediastinum on roentgenograms of the chest.

Of the 12 cases of brain tumor studied, 4 failed to show any pathologic change of the cerebral vessels: 2 brain-stem gliomas, 1 craniopharyngioma, and a cystic cerebellar astrocytoma. Five tumors of the cerebral hemisphere were shown definitely by the arteriograms. Astrocytomas and hemangioblastomas appeared as avascular areas spreading the arteries in the cortex. Glioblastomas displaced the vessels, but there was increased vascularity in the cortex in the area where the tumor extended to the surface of the hemisphere, with the large veins forming a corona. These tumors sometimes showed neoformations of small vessels within the substance of the neoplasm itself.

Internal hydrocephalus is recognized by characteristic alterations in the vascular pattern. This consists of a broad curve of the middle cerebral artery and a wide curve of the anterior cerebral artery around the corpus callosum.

In "hydroencephalodysplasia," which is an extensive cerebral dysplasia with a collection of fluid under pressure (to be distinguished from true internal hydrocephalus), the internal carotid artery is small and hypoplastic, and its branches are abnormal, incomplete, or absent. The sylvian group has been seen to be formed by only two arteries running parallel to one another, without branches. The internal carotid artery may end abruptly in a small bunch of fine vessels. In porencephaly, also, there may be absence of part of the cerebral circulation.

Angiography is most spectacular in the demonstration and diagnosis of blood vessel malformations and aneurysms. In 2 cases of Sturge-Weber syndrome the angiograms failed to show abnormalities, and in a case of Parke-Weber congenital hemangiectasis the cerebral vessels were normal in spite of the fact that the patient had suffered from convulsions. In another case, in which there were extensive arteriovenous malformations of the extracranial blood vessels, angiography failed to reveal intracranial abnormalities.

Twelve roentgenograms; 1 table.

HOWARD L. STEINBACH, M.D.
University of California

Clinical Complications of Cerebral Angiography. Kenneth H. Abbott, James R. Gay, and Robert J. Goodall. J. Neurosurg. **9:** 258–274, May 1952.

The authors report the untoward effects of cerebral angiography as encountered clinically in 150 patients upon whom 174 cerebral angiographic studies were performed. Serious complications were encountered in 17 cases, with 5 fatalities. Details of these cases are included. In 2 instances less serious though alarming signs were noted.

Complications of cerebral angiography are undoubtedly due to several factors, one or more of which may operate in any one untoward incident. These factors may be (1) mechanical and hydrodynamic factors; (2) reflex vasospasm; (3) direct chemical vasospasm; (4) disturbances in blood-brain barrier; (5) introduction of air and of (6) blood clot embolism; (7) sensitivity to the drug; (8) severe dilution of the carotid blood with saline.

The authors believe that Thorotrast is the medium of choice in those patients in whom degenerative or inflammatory cerebral vascular disease is suspected.

HOWARD L. STEINBACH, M.D.
University of California

Expanding Intracranial Lesions in Childhood. Harold D. Palmer and Edward S. Murphy. J.A.M.A. **149:** 220–227, May 17, 1952.

The authors reviewed 104 cases of expanding intracranial lesions in children (90 histologically proved) seen in a twenty-two-year period. Forty-nine of these were gliomas, tumors of the ependymoma group being the most frequent. Medulloblastoma was next in frequency, followed by astrocytoma. The gliomas were commonly infratentorial in location, as borne out by other studies. Common initial symptoms of all lesions were vomiting and headache. Convulsions were notably infrequent. Routine skull roentgenograms were positive in two cases out of three, showing widening of sutures, intracranial calcification, and distortion or erosion of the calvarium. Ventriculography in 24 cases showed localizing findings in 13 and "hydrocephalus" in 10. Although one death occurred during ventriculography, the authors consider the procedure less hazardous than "exploratory craniotomy."

The article lists and briefly discusses a classification which encompasses not only gliomas and other common categories but tumors of neuroectodermal, meningeal, notochordal, and vascular origin. Tumors near the sella turcica and those arising from the cranial nerves and calvarium are also included, as are infectious granulomas and metastatic lesions.

One drawing; 2 tables. D. D. ROSENFELD, M.D.
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The Diagnosis and Differential Diagnosis of Meningioma. L. Psenner. Fortschr. a. d. Geb. d. Röntgenstrahlen **76:** 567–579, May 1952. (In German)

It is not too well recognized that meningioma, not only of the anterior fossa, but also of the middle fossa, the posterior fossa, and the vault, may yield highly diagnostic roentgen signs directly on the plain skull films. The four roentgen signs to be seen on the routine film are hyperostosis, bone erosion, abnormal vascularity, and abnormal calcification.

Most commonly hyperostosis is manifest as an extensive area of sclerotic, thickened bone, usually at the base

of the skull. While regional, unilateral, or relatively demarcated, it is never intrinsically limited by a suture line. Hyperostosis of the base of the skull must be distinguished from idiopathic sclerosing hyperostosis, osteoblastic metastases, and syphilis. The idiopathic variety affects either the sphenoid or the maxilla, does not cross the suture lines, and is quite smoothly contoured. Metastatic lesions may be difficult or impossible of differentiation early. Later the development of multiplicity, frequently with discovery of the primary neoplasm, reveals their true nature. In Psenner's experience, syphilis has always shown multiple bone involvement regional to the paranasal sinuses.

An osteoblastic reaction of the vault may result from a multitude of disease processes. Nevertheless, an initial impression that it is due to meningioma is often correct. It is true for example, in theory, that hyperostosis frontalis interna is not distinguishable from meningiomatous hyperostosis. In practice, the typical distribution and pattern of the former seldom initiate further fruitless study. Benign osteomas are readily detectable as such. The hyperostosis following trauma and bone changes secondary to an arteriovenous aneurysm as an ossification *ex vacuo* may both stimulate study of the underlying brain, but such studies are seldom unrewarding. The formation of spicules on the external table may occur with a meningioma but is not characteristic. Spicules are most regularly found in hemangioma. They may also be seen in sarcoma, metastatic carcinoma, and some systemic diseases. Fine spicules projecting internally do not come in this category. These, whether from the base of the skull or the vault, may represent the comb-like or pectinate hyperostosis which is characteristic of meningioma. This appears in no other disease and when seen permits an immediate diagnosis.

Bone erosion has been noted particularly in meningiomas adjacent to the parietal bone. In itself it is not diagnostic. Likewise abnormal vascularity is not a specific sign, for one must consider both the possibility of a normal variant and the influence of a neighboring glioma. A heavy, somewhat irregular marble-like calcification, is suggestive of the possibility of meningioma, but a calcified hematoma is more likely.

The author reviewed 50 cases of meningioma which showed changes on the routine skull films. On 3 the pathognomonic pectinate hyperostoses were recognized. Highly suggestive diffuse hyperostoses were noted in 18. The remainder exhibited hyperostosis, erosion, and abnormal vascularity sufficient for comment, though not for a definite statement as to the diagnosis.

Nineteen roentgenograms.

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An Unusual Case of Extra-Dural Haematoma. K. G. Jamieson. Australian & New Zealand J. Surg. **21:** 304–307, May 1952.

In extradural hematoma resulting from a skull fracture extending across a branch of the middle meningeal artery one certainly expects to elicit a history of head injury. In the case presented no history of injury was given. Instead there was a sudden onset of headache with increasing neurological signs and the presence of blood in the spinal fluid. Cerebral angiography was performed because the clinical picture was thought to be due to a ruptured aneurysm. On the lateral film a fracture of the skull and the actual bleeding site were demonstrated, while the anteroposterior position showed the extent of the clot. Craniotomy was done immediately with good results.

The only clue to the injury was the knowledge obtained from the family that the night before the onset of symptoms was spent "out," presumably drinking. Plain films should have been obtained on this patient, but then the literature would have been deprived of a most interesting angiographic study.

Four roentgenograms. Zac F. Endress, M.D.
Pontiac, Mich.

Value of Pneumoencephalography in Diagnosis of Fits. John Marshall and C. W. M. Whitty. Brit. M. J. **1:** 847–849, April 19, 1952.

Fifty-six patients who had epilepsy in early adult life were subjected to pneumoencephalography. Four had had abnormal physical signs; 3 of these had definitely abnormal air pictures, and the fourth a doubtful abnormality. Of the 52 patients with no abnormality on clinical examination, 51 had normal air pictures. The 5 cases with definite or possible encephalographic abnormalities are briefly reported.

It is suggested that the diagnostic value of pneumoencephalography in young adults with epilepsy as their only abnormality is not great, and that it is better to keep these patients under neurological observation until the emergence of clinical signs indicates the need for air studies.

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Optic Atrophy Caused by an Arteriovenous Angioma. Report of a Case. Raymond I. Band. Arch. Neurol. & Psychiat. **67:** 655–660, May 1952.

The author reports a case of bilateral optic nerve atrophy and blindness of the left eye without any other signs or symptoms. An arteriogram of the right internal carotid system disclosed a plexus of abnormal blood vessels in the supraclinoid region. Because of the rapid filling of these vessels during the arteriographic procedure, and because of the reddish color of the blood seen at operation, the lesion was thought to be an arteriovenous angioma.

Two somewhat similar cases are cited from the literature (Dandy: Arch. Surg. **17:** 715, 1928; Brock and Dyke: Bull. Neurol. Inst., New York **2:** 247, 1932).

Four roentgenograms. Daniel Wilner, M.D.
Atlantic City, N. J.

Intranasal Chondrosarcoma. Report of a Case. Lawrence J. Lawson. Arch. Otolaryng. **55:** 559–565, May 1952.

Chondroma and chondrosarcoma rarely involve the paranasal sinuses and intranasal structures. Distinction between the two tumors may be difficult. A chondroma is a firm, lobulated, grayish tumor arising either from the surface or from the interior of the short bones of the hands and feet, from the ends of the long bones, or from the flat bones, notably from the pelvis, sternum, and scapulae. X-ray examination reveals partial or complete destruction of bone. The growth is frequently lobulated and multilocular and has irregular but sharp margins. Microscopically it is composed of atypical cartilage cells having no particular pattern of orientation. While chondromas are benign in the sense that they grow slowly and exhibit histologically a high degree of differentiation, they are capable of local inva-

sion and tend to recur after any operative procedure short of complete excision of the tumor and all adjacent tissues. A chondrosarcoma usually arises from a previously existing chondroma. It is more frequently found on the surface of the bone. In most instances the transition is gradual, and it may be easier to determine the change by the clinical history and x-ray studies than by histologic examination.

The case reported is that of a 76-year-old woman, a diabetic, who, when first seen by the author, had a high-grade intranasal obstruction, chiefly right-sided, and a purulent right nasal discharge. Immediate roentgenograms of the paranasal sinuses revealed clouding of the right antrum, with extensive destruction of its outer and medial walls. The infection cleared with antibiotic therapy, and further x-ray studies showed the tumor to involve the infraorbital rim. Seven years earlier a chondroma had been removed, which completely filled the left nostril, pressed upon the medial wall of the antrum, and displaced the nasal septum far to the right. Previous to the operation the patient had received forty-four x-ray treatments in fifty-seven days (dosage not given).

The tumor of the right nostril and right antrum was excised. The bony portion of the nasal septum was thick and friable; the intranasal tumor appeared to originate in the septum. The histologic diagnosis was chondrosarcoma. Post-operatively, in a period of sixteen days, roentgen therapy was given over the right antrum anteriorly and laterally, through two 4 × 6-cm. ports, for a total skin dose of 3,550 r and a tumor dose of 2,485 r. At the time of the report the patient was comfortable, with reasonably good nasal ventilation. Small lobules could be felt on the orbital surface of the right lower orbital rim, but these had not increased in size in many months.

A case of chondrosarcoma of the nasopharynx in a 16-year-old boy (Wirth and Shimkin: Arch. Path. **36:** 83, 1943) is reviewed to illustrate the different behavior of chondrosarcoma at the opposite end of the life span.

Rhinologists confronted with a tumor of this type must decide whether conservative treatment, with probable recurrence, is justified, or whether a radical procedure should be carried out in an attempt to destroy the tumor completely, even though this may mean disability and disfigurement. The results of irradiation are disappointing.

Three roentgenograms; 3 photomicrographs.

Two Cases of Anomalies in the Occipito-Cervical Region. Ph. Sarasin. Schweiz. med. Wchnschr. **82:** 519–520, May 10, 1952. (In French)

Two female patients, aged 24 and 55, were seen with vague neurologic disturbances of the extremities. In the first, the odontoid process was very small, with large anterior osteophytes at the C3-4 and C5-6 levels. A slight subluxation of C2 is postulated. In the second case, in addition to the abbreviated odontoid, there were accessory occipital condyles which apparently articulated with the transverse processes of the axis.

Three roentgenograms. CHARLES NICE, M.D.
University of Minnesota

Lateral Cervical Sinus. Report of Three Cases with Brief Review of the Literature. Philip B. Parsons. Am. J. Roentgenol. **67:** 757–762, May 1952.

The author reports three cases of lateral cervical sinus and briefly reviews the literature on the subject.

Whether lateral cervical sinuses arise from the thymopharyngeal duct or whether they are branchial cleft remnants is still subject to considerable debate following extensive investigation. Three main types are seen, including complete fistula with outer and inner openings, incomplete external sinuses with an outer opening only, and incomplete internal sinuses with inner openings only.

All 3 of the author's patients were male. The first, aged 19, had a small elevated area just above the right sternoclavicular junction, with occasional watery discharge for eight years. Lipiodol injection showed the sinus tract arising ventrally at the level of C7, draining into the pharynx in the region of the right palatine tonsil. The tract was excised; the pathologic studies indicated that the lesion arose from an internal branchial furrow. On the left a portion of cord-like structure was removed from the same level, and the microscopic report was the same as on the right. The second patient, 30 years old, had a pin-point opening in the same location as the first patient, with persistent drainage for many years. Lipiodol injection and surgical excision were as above, other than for a small abscess involving the wall of the sinus. The third patient, 14 years old, had had a mass on the right side of the neck incised and drained two years before. Drainage persisted and Lipiodol injection showed a cystic structure immediately beneath the skin, with a long narrow sinus tract terminating rostrally in the esophagus at the level of the pharynx. The patient refused further surgery.

Six roentgenograms. BERTRAM LEVIN, M.D.
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THE CHEST

A Relatively Simple Method of Bronchography for the Radiologist. J. A. Meadows, Jr. South. M. J. **45:** 415–420, May 1952.

The author uses a modification of a bronchographic technic employed by Schmidt (Proc. Staff Meet., Mayo Clinic **23:** 71, 1948), in which the contrast medium is introduced through a tracheal catheter. He describes in detail the preparation of the patient, the method of inserting the catheter between the vocal cords and into the trachea, and the technic of filling the bronchial tree. Twenty cubic centimeters of 40 per cent Lipiodol are used for each lung. Following injection of the right lung, postero-anterior Bucky and posterior oblique films are obtained. The left lung is then filled and a left posterior oblique film is taken, as well as a second postero-anterior view. Aspiration following each injection and set of films has been found to be a wise precautionary measure.

This method can be carried out adequately by the radiologist. In less than 5 per cent of his cases has the author found it necessary to call upon the bronchoscopist for help in inserting the catheter. No fluoroscopy is required, the only use of the fluoroscopic table being to tilt the patient for distribution of the Lipiodol in the bronchial tree.

Eight roentgenograms; 5 photographs.

W. A. NAFIS, M.D.
Jefferson Medical College

Bronchography in Bronchial Cancer and Collateral Ventilation. Eelco Huizinga. J. Thoracic Surg. **23:** 445–452, May 1952.

Three case histories are presented of patients with

bronchogenic carcinoma partly or completely occluding a bronchus. In each instance the bronchial occlusion was demonstrated by bronchoscopy and bronchography, and the final diagnosis was made by biopsy. The unusual feature of these cases was that, while roentgenograms showed hilar widening, in no instance was there atelectasis of the involved lobe or segment. This is attributed to "collateral ventilation," the air apparently being brought into the blocked-off area from an uninvolved segment.

The author refers to a series of 160 cases of bronchial carcinoma in many of which bronchoscopy was preceded by bronchography. This latter procedure gives the bronchoscopist a better idea of the area of involvement, enabling him to perform a so-called "directed bronchoscopy" and, though he may not see the lesion, to obtain a "blind biopsy." In 123 of the 160 cases, or 77 per cent, a positive biopsy was obtained by directed bronchoscopy. In 17 of these the biopsy was of the "blind" type.

Six roentgenograms. C. J. CORRIGAN, M.D.
St. Paul, Minn.

Lung Lesions Following Bronchography with an Absorbable Iodine Preparation, in Particular Ioduron B. Magnenat. I bronchi **1:** 165, 1951. Abst. in Radiol. med. (Milan) **38:** 477, May 1952. (In Italian)

The author reports on three autopsies performed at the Pathological Institute of the University of Lausanne in patients who had been subjected to bronchography with Ioduron B. In all cases the presence of foreign-body granulomata testified to the intensity of the reaction caused by this opaque medium.

CESARE GIANTURCO, M.D.
Urbana, Ill.

Pulmonary or Bronchial Lavage and Simultaneous Tomographies. Manoel de Abreu. Dis. of Chest **21:** 460–476, April 1952.

Mass fluorography has provided a fast method for detecting abnormal shadows in the lungs, but there remains the problem of developing a rapid and precise method for establishing the etiology and activity of the positive cases. For the determination of the activity of a suspected tuberculosis, the author uses a combination of bronchopulmonary lavage and simultaneous tomography. In the latter procedure three focal planes are recorded during a single tube travel. The films and tube are in motion, and the films are stacked in a special cassette in a plane parallel to the planes of focus. For the lavage 10 to 20 c.c. of physiological saline are introduced into the pharynx after proper anesthesia. When rhonchi are heard, the patient is asked to cough and thus furnish a specimen for bacteriologic study.

The author has found close agreement between tomographic findings and the results of lavage. If the lesion appears exudative or contains a cavity, the lavage is positive in the vast majority of instances (direct, culture, or inoculation). If the lesion appears fibrotic or fibrocalcific, the lavage findings are usually negative. If x-ray signs appear positive and lavage findings negative, the lavage is repeated and the activity of the lesion is usually confirmed. In all cases of positive lavage there is radiographic and bacteriologic agreement.

In the discussion of this paper, Dr. H. G. Trimble agreed with the author's opinion that pulmonary lavage is more rapid and more accurate than gastric lavage. He also pointed out that tomographic interpretation has been shown to be in error in as many as 50 per cent of cases according to some postmortem studies. More study of this procedure is needed, with pathological correlation.

Twenty-eight roentgenograms; 1 photograph; 3 diagrams. D. D. ROSENFELD, M.D.
Fontana, Calif.

Routine Chest Examinations in a Private General Hospital. J. P. Medelman and John F. Briggs. Minnesota Med. **35:** 340–344, April 1952.

The authors describe the chest survey methods used in a hospital having approximately 10,000 admissions yearly (exclusive of the pediatric service). The photofluorographic technic is used, with 4 × 5-inch films. The photoroentgen unit is located about 150 feet from the admitting office, but even this short distance is held to be too great for the best results. Student technicians and admitting office personnel are charged with operation of the unit.

Since the primary purpose of the survey is the discovery of cases of infectious tuberculosis as a measure of protection to hospital personnel and patients, the keeping of records has been greatly simplified. The report is attached to the patient's chart, and the film with a duplicate report, is filed in the x-ray department.

In the first year of operation of the survey, 10 cases of tuberculosis requiring active treatment and 200 cases of tuberculosis of reinfection type, of undetermined significance, were discovered. There were also found 17 tumors, 212 cardiovascular abnormalities, and a variety of other conditions.

Seven photofluorograms.

An Accessory Lung. Report of a Case. Bert H. Cotton, Keith Spaulding, and Joao R. F. Penido. J. Thoracic Surg. **23:** 508–512, May 1952.

This is a report of a true accessory lung discovered in a female infant of two months with a history of persistent cough from about the second day of life. Anomalies of the lower cervical vertebrae and a hip deformity were also present. A chest roentgenogram revealed a homogeneous shadow occupying the upper two-thirds of the right hemithorax, suggesting atelectasis of the right upper lobe. A bronchogram showed a stem bronchus coming directly off the bronchial tree to the right and a saccular bronchiectasis in the area of density previously demonstrated. A diagnosis of saccular bronchiectasis of the right upper lobe was made and surgery was advised.

At operation, several months later, a complete accessory lung was found consisting of three separate lobes, each within its own pleural sac and connected to a main bronchus arising from the trachea above the normal right main bronchus. The lung was drained by two veins. Its arterial supply was furnished by a branch coming directly off the subclavian artery and entering at the apex. The parenchyma was filled with cystic spaces. The bronchioles were dilated and a considerable amount of honeycombing was present.

After removal of the anomalous lung, the anesthesiologist applied positive pressure, expanding the true lung to fill the hemithorax. Convalescence was uneventful, and a year later the child was free of respiratory symptoms.

Four roentgenograms; 2 photographs.

C. J. CORRIGAN, M.D.
St. Paul, Minn.

Congenital Direct Communication Between Biliary System and Respiratory Tract. Edward B. D. Neuhauser, Milton Elkin, and Benjamin Landing. Am. J. Dis. Child. **83:** 654–659, May 1952.

A unique communication was discovered by the authors between the right main bronchus and hepatic duct of a 5-month-old baby. Diagnosis was made by bronchography during life, but the infant died of pneumonia and respiratory obstruction before surgery could be performed. Respiratory symptoms and signs had been constant from the fourth day of life, due to the constant flow of bile into the bronchial tree.

Histologically the tract resembled the trachea in its upper portion, the esophagus in the middle portion, and bile ducts in the lower portion. The authors postulate either a duplication of the intestinal tract or, more likely, the fusion of anomalous buds from the bronchial and hepatic anlagen. No similar case was found in the literature.

Three roentgenograms; 1 photograph.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

A Case of Herniation of the Pulmonary Apex. Ravazzolo Sinclair. Radiol. clin. **21:** 201–210, May 1952. (In Italian)

An unusual case of herniation of the pulmonary apex into the base of the neck in a child 10 years of age is presented. The hernia was first noticed by the parents of the patient during his early childhood as a swelling in the right side of the neck, apparent whenever he cried. The tumefaction increased in size with the years and the child learned that he could make his neck larger by holding his breath and bearing down. The author was able to show that the tumefaction was caused by a herniation of the pulmonary apex.

Four roentgenograms. CESARE GIANTURCO, M.D.
Urbana, Ill.

Diagnostic Problems of Cancer of the Lung. Seymour M. Farber, Mortimer A. Benioff, and Judith D. Smith. California Med. **76:** 328–332, May 1952.

There are three technics of primary significance in the diagnostic problems of cancer of the lung.

Roentgenologic examination is generally the first diagnostic procedure utilized when there are symptoms and signs of a pathologic process in the thoracic cage. This will confirm the presence of an abnormality in most cases. Unless the tumor body is very small and there are no secondary processes, some pathologic lesion will be evident. Roentgenologic appearances, however, are not specific. Most commonly, atelectasis will be clearly evident, but the tumor may be concealed in the collapsed portion of the lung. Secondary infectious processes, also, often completely mask the tumor body. At times the neoplasm is visible but appears only as strands along the usual lung markings.

The potential contribution of bronchoscopy is widely debated, even though the technic has been in general use for many years. It has been claimed that morphologic evidence of cancer, or reasonably presumptive evidence, can be obtained by bronchoscopy in from 30 to 60 per cent of all cases. The usefulness, of this procedure, however, is limited to lesions in the major bronchi.

For the third technic, cytologic study, to be effective, it is apparently necessary only that there be a free passageway between the trachea and the tumor body. Cytologic studies were carried out in 2,066 cases of all types of diseases of the chest, including 241 bronchogenic carcinomas proved by one means or another. The presence of cancer was diagnosed cytologically in 55 per cent of the 241 cases. When five specimens of sputum from each patient were examined, the efficiency of the technic rose to 90 per cent.

Three roentgenograms; 3 photomicrographs.

HOWARD L. STEINBACH, M.D.
San Francisco, Calif.

Jaundice with Signs of Extra-Hepatic Obstruction as the Presenting Symptom of Bronchogenic Carcinoma. Donald Berkowitz, Joseph M. Gambescia, and Charles M. Thompson. Gastroenterology **20:** 653–657, April 1952.

In reviewing the literature, the authors found only one report, without details, of jaundice as a symptom in patients with bronchogenic carcinoma.

They describe the case of a 56-year-old white male who was seen with jaundice of four weeks duration with a palpable liver and gallbladder. Eight weeks prior to admission he suddenly became ill, with vomiting and abdominal pain, which abated after one week but recurred. His urine became dark and stools light.

Roentgenograms of the chest on admission showed atelectasis of the left upper lobe and a left hilar mass. A gastrointestinal series showed the stomach displaced anteriorly and to the left as well as distortion of the duodenum and duodenal loop, although the intrinsic mucosal pattern appeared normal. Bronchoscopy revealed a tumor in the left upper lobe orifice and main stem bronchus. The left vocal cord was paralyzed. The patient died on the twenty-third hospital day.

Autopsy revealed an anaplastic bronchogenic carcinoma of the left upper lobe. There were metastases to the peribronchial lymph nodes, the liver, the peripancreatic tissues, and the common bile duct. The metastases involving the bile duct were in the form of an encircling mass near the ampulla, completely obliterating the lumen.

One roentgenogram; 1 photomicrograph.

PAUL R. NOBLE, M.D.
Pittsburgh, Penna.

Pneumoconiosis in Irish Colliery Workers. James Deeny, N. F. Walsh, and M. M. Conran. Irish J. M. Sc., pp. 193–206, May 1952.

Until the survey here reported was made, there was no knowledge as to the incidence of pneumoconiosis, its severity, or the particular form among Irish coal miners. Preliminary to their report on this group of workers, the authors discuss the pathology of pneumoconiosis, following Belt and Ferris' classification of four main types: simple diffuse anthracosis, nodulation, the collagenous nodule, and the coalesced nodule.

There are two main theories of causation. The mechanical theory maintains that the lung damage is due to the sharp corners of the silica particles, which pierce the tissue cells. The sericite theory holds that "sericite" or hydrated aluminum and potassium silicate is the essential factor, which, although it may not cause the disease by itself, is necessary to reinforce the action of some other agent.

The survey consisted first of a screening of 1,133 miners with a 70-mm. x-ray unit. Of these, 132 showed abnormalities and were asked to return for more de-

tailed examination. A large film was then taken and a physical examination was done. The cases were classified according to the method of the Medical Research Council of England, which divides cases into simple and complicated and then subdivides them into 4 groups in stages of increasing severity. The subdivisions depend on the amount of lung tissue involved and the characteristics of the opacities.

There was a direct relationship of incidence of the disease to age and of age to the length of time in contact with dust.

Clinically, there were three recognizable stages of anthracosilicosis. First, a mild bronchitic stage, characterized by a dry bronchitis; secondly, a more pronounced bronchitis, thought to be related to the nodular stage, characterized by small aggregates of lymphoid tissue in the lungs and fine fibrosis; and thirdly, a severe stage, believed to be indicative of gross fibrosis complicated and possibly produced by a superadded, not necessarily tuberculous, infection. The steps from the first to the third stage are gradual and not sharply differentiated one from the other. In Stage 1 there was little exercise intolerance and slight orthopnea; cough was present. In the second stage orthopnea was more pronounced. In Stage 3 most of the men were not fit for work; they were markedly dyspneic on normal quiet walking. The signs and symptoms encountered were applicable to many chronic chest complaints, and the industrial history is of paramount importance in making the differential diagnosis.

The assessment of disability can be made only by correlating all available information, including working history, medical history, radiological findings, physical examination, and sputum and other pathological tests required to determine the differential diagnosis.

In one of the two coalfields studied, where hard coal was mined, 1 in 17 workers showed changes in the lungs due to dust disease. In the soft-coal field the percentage was much less. It is felt that this is due to the large amount of fire clay in the hard-coal area which is absent in the soft-coal field studied. Fire clay is rich in aluminum silicate.

Among the total number of men examined radiologically, 7 cases of tuberculosis were found, 1 complicated by pneumoconiosis. The number of cases of anthracosilicosis found was sufficient to indicate the presence of a serious hazard to the health of workers in the industry.

Five roentgenograms; 5 tables.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Pulmonary Infiltration with Eosinophilia (PIE Syndrome). William H. Reeder and Ben E. Goodrich. Ann. Int. Med. **36:** 1217–1241, May 1952.

Similarities between Loeffler's syndrome and tropical eosinophilia have been noted in the literature, and a possible relation to other diseases of suspected allergic origin has been mentioned. Since the common feature of these conditions is the coexistence of pulmonary infiltration and eosinophilia, the authors feel that the specific designations Loeffler's syndrome and tropical eosinophilia might well be discarded and the term PIE syndrome (pulmonary infiltration with eosinophilia) substituted. This, along with the primary, subsidiary, or modifying diagnosis, as for example "PIE syndrome, bronchial asthma," has descriptive appeal and presents a clear word picture.

Use of this term allows inclusion of cases with recurrent and protracted course not logically called Loeffler's syndrome or tropical eosinophilia. A search should be made for accompanying disease of known or suspected allergic origin, especially bronchial asthma, angioneurotic edema, hay fever, eczema, migraine headache, serum sickness, rheumatic fever, rheumatoid arthritis and collagen-vascular diseases. The differential diagnosis in PIE syndrome should include eosinophilic leukemia, Hodgkin's disease, periarteritis nodosa (sometimes an accompanying diagnosis), pulmonary tuberculosis, fat embolism, infectious mononucleosis, septicemia, and pneumonia of rheumatic, bronchial, lobar, aspiration, or viral type.

Many cases of PIE syndrome are asymptomatic and of a mild and transient nature, apparently produced by reversible tissue reaction. When more severe damage results in symptomatic chronicity and progression, concentrated therapeutic effort is indicated. Ultimate recovery may be enhanced by early diagnosis and prompt institution of treatment.

Within a period of eighteen months the authors encountered 8 cases of this syndrome with various accompanying conditions. Four are reported here. Two represent a reversible process without demonstrable residual effects. In the third case the accompanying disease was more severe and the course was prolonged. The fourth case was associated with a periarteritis nodosa and terminated fatally, though the pulmonary infiltration had cleared before the patient's death.

Thirteen roentgenograms; 1 photomicrograph; 3 temperature charts. STEPHEN N. TAGER, M.D.
Evansville, Ind.

Hydatid Cyst of the Lung. Two Unusual Cases. M. P. Susman. Australian & New Zealand J. Surg. **21:** 297–299, May 1952.

After a hydatid cyst ruptures into the bronchial tree (a frequent and sometimes nearly asymptomatic complication), developmental cysts and pneumothorax must be considered in the differential diagnosis.

Two cases are reported and illustrated in which rupture had occurred. In 1 patient, aged seven, multiple cysts resulted, presumably due to direct spread of scolices by way of the bronchi. At the time the report was made seven cysts had been removed and one still remained.

Eight roentgenograms. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Situs Inversus Viscerum and Bronchiectasis. Report of a Bantu Case Associated with Chronic Cor Pulmonale and Renal Anomalies. L. D. Erasmus. South African M. J. **26:** 429–433, May 24, 1952.

The author reviews the literature on the association of situs inversus and bronchiectasis and reports an example of the condition in an adult South African Bantu, with congestive cardiac failure, a large pulmonary artery and renal anomalies. The roentgen findings are described. The cardiac failure in this case was attributed to chronic cor pulmonale. The patient had two kidneys on the right side; the superolateral kidney had two ureters which fused with each other, the common stem joining the ureter of the medial kidney lower down.

Three roentgenograms; 1 electrocardiogram; 1 drawing.

Misinterpretation of Findings in Catheterization of Anomalous Pulmonary Veins Adjacent to a Mediastinal Dermoid Cyst. George E. Welch, K. Alvin Merendino, and Robert A. Bruce. J. Thoracic Surg. **23:** 495–501, May 1952.

A young adult male with occasional palpitation on exertion was found on roentgen study to have a pulsating mass in the chest continuous with the heart shadow. It was observed to diminish in size with the Valsalva maneuver. Extensive examinations and cardiac motion studies showed the heart function to be essentially normal.

Cardiac catheterization was carried out, the catheter being passed down the superior vena cava from the arm. In the course of the procedure, the tip of the catheter entered an anomalous vessel from which highly oxygenated blood of a higher than ordinary venous pressure was obtained. This led to the conclusion that the mass observed roentgenologically was probably an arterio-auricular aneurysm or an angiomatous tumor with an auricular communication. Upon surgical exploration, however, a mediastinal dermoid cyst was found and removed. Further dissection of the right hilus, prompted by the findings on catheterization, showed the pulmonary venous drainage of the right lung to be provided by three veins: a large vein from the upper lobe, emptying into the superior vena cava; a smaller vein from the middle lobe, emptying directly into the auricle; the inferior vein in normal position. It was from one of the anomalous veins that the highly oxygenated blood was withdrawn on catheterization.

The authors emphasize the importance of keeping in mind the possibility of anomalous venous drainage, especially if removal of part of either lung is considered. Interference with or removal of the normal drainage in the opposite lung in these cases may lead to disastrous results. It is stated that "when less than 50 per cent of the pulmonary venous return enters the right auricle the patient has no symptoms, there is little likelihood of decompensation, and the life span need not be shortened."

Five roentgenograms; 1 photograph.

C. J. CORRIGAN, M.D.
St. Paul, Minn.

Aortography in Roentgen Diagnosis. Raymond R. Lanier, Robert V. Elliott, and Morris H. Levine. Rocky Mountain M. J. **49:** 427–434, May 1952.

Ten cases are presented to indicate the range of diagnostic usefulness of aortography and to demonstrate the simplicity of the procedure and its relative safety. Among the conditions which may be studied with profit by this means are aortic thrombosis, abdominal aneurysms, neoplasms, and placenta praevia. In one of the cases reported, the procedure was useful in demonstrating an adequate divisible blood supply to the kidney prior to elective surgery.

The technic followed by the authors is that recently described by Smith and his associates (J. Urol. **65:** 911, 1951. Abst. in Radiology **58:** 785, 1952) and by Sante (Radiology **56:** 183, 891, 1951). Neo-iopax (75 per cent), Urokon (70 per cent), or Diodrast is used as the contrast medium. An ordinary 200-ma. x-ray unit with a Bucky apparatus has been found satisfactory, though in two instances (out of 30) it was realized that serial films in rapid succession would have been advantageous.

Fifteen roentgenograms.

Coarctation of the Aorta Complicated by Dissecting Aneurysm in Pregnancy: Report of a Case with Survival, Studied by Arteriography. Robert H. Furman, J. Allen Kennedy, and Rollin A. Daniel, Jr. Am. Heart J. **43:** 765–772, May 1952.

When death due to cardiovascular complications occurs during pregnancy or shortly after delivery in women with coarctation, the commonest cause is dissection of the aorta. An earlier review is cited which indicates that pregnancy may predispose to aortic dissection, particularly in the presence of a congenital anomaly of the aorta. The authors report what they believe to be the fifth case of dissecting aneurysm in 44 reported cases of coarctation of the aorta in pregnancy. Seven of the 44 patients died during pregnancy, including 4 in whom a dissecting aneurysm developed. The authors' patient is relatively symptom-free more than one year following diagnosis and exploratory thoracotomy.

Retrograde angiograms in this case are presented and discussed. The question is raised as to whether the retrograde injection of contrast material in this instance might have produced intimal tearing with dissection. A note of caution is sounded regarding the use of procedures requiring the interruption of the integrity of a vessel wall of the caliber and importance of the carotid artery or the rapid injection of relatively large volumes of materials against a high head of pressure in a diseased vascular system.

Six aortograms.

An Unusual Variant of Double Aortic Arch. Mortimer Lubert, Harold C. Epstein, Harvey Mendelsohn, and Samuel O. Freedlander. Am. J. Roentgenol. **67:** 763–776, May 1952.

The authors state that it is probable that the case which they report represents the first example of a preoperatively diagnosed double aortic arch with dominant left arch, left retroesophageal and right descending aorta.

The patient was a four-month-old white boy with a history of one episode of upper respiratory infection with stridor. His mother had noticed that, on feeding, he would take only a few swallows before having to rest. He was admitted to the hospital with tracheobronchitis, emphysema, and expiratory stridor.

Roentgen studies revealed a large indentation on the left border of the esophagus at the level of the aortic arch and a smaller one on the right, at a slightly lower level. An oblique filling defect connected the two. The esophagus descended more to the left than usual. A retroesophageal impression was present, as well as a shallow, longer and higher anterior impression. The findings were interpreted as indicating a double aortic arch with dominant left aortic arch, left retroesophageal and right descending aorta. This impression was confirmed at operation. Following surgery the patient improved considerably.

Although this anomaly is rare, it seems probable that some cases are missed if a retroesophageal aorta is considered only as evidence of a right aortic arch. Considerable care in the roentgen study is necessary to differentiate between a right aortic arch existing alone, the more usual variant (dominant right aortic arch with retroesophageal component and descent on the left), and the anomaly reported here. The exact diagnosis is important to the surgeon, since the operative approach must be made from the side of the descending aorta

The nature of this defect from the anatomic point of view is discussed, as is that of the more usual type of double aortic arch. The roentgenologic findings are elucidated. The position of the descending aorta is important; if it descends on the left, the esophagus will be in normal position; if on the right, the esophagus should be displaced to the left. The distinction between a left aortic arch with a right descending aorta and the double aortic variant which is similar to it is discussed. The course of the retroesophageal portion of the left aortic arch is probably of greatest importance in the differential diagnosis. In double aortic arch with right descending aorta the retroesophageal portion has a more horizontal course, being supported by the right arch. In left aortic arch with right descending aorta the retroesophageal portion takes a more oblique course, being considerably higher on the left.

The authors caution that in studying the esophagus it must be adequately filled with barium to reveal all the indentations and their true size and position.

A number of clay model illustrations are shown, depicting the nature of the anomaly, as well as 16 preoperative and postoperative roentgenograms of the reported case. A chart schematically represents the more important "vascular rings" which must be considered in differential diagnosis.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

THE DIGESTIVE SYSTEM

Primary Adenocarcinoma of the Esophagus Simulating a Benign Lesion. Joseph L. Goldman, R. H. Marshak, and A. I. Friedman. J.A.M.A. **149**: 144–145, May 10, 1952.

A case of primary adenocarcinoma of the lower third of the esophagus is reported. This esophageal adenocarcinoma simulated a benign tumor, being completely encapsulated and submucosal. It was extraluminal, yet entirely intramural, and on roentgen examination it presented the characteristics of a benign lesion, *i.e.*, a smooth filling defect with no destruction or distortion of the normal mucosal folds. Ulceration into the mucosa had not yet occurred, though undoubtedly, had the lesion not been identified, it would have eventually broken through into the lumen of the esophagus. A definitive diagnosis in this case could be made only by histopathological examination of tissue obtained by esophagoscopy.

Five roentgenograms.

The Significance to the Surgeon of the Roentgen Ray Flat Plate (Scout Film) in the Diagnosis of Acute Abdominal Disease. Samuel McLanahan, Charles H. Watt, Jr., and John S. Green, III. Ann. Surg. **135**: 586–595, May 1952.

A plea is made to the surgeon to become better educated regarding the value of the abdominal scout film and its interpretation, particularly as expert radiological advice may be unavailable in emergencies.

When the surgeon undertakes to interpret an abdominal film, he should have an established systematic plan of study. The following approach is suggested:

1. Osseous structures.
2. Extra-abdominal soft-tissue and gas shadows.
3. Five regions or organ groups which contain many normally or pathologically visualized abdominal structures:
   - A. Subdiaphragmatic regions.
   - B. Liver and gallbladder region.
   - C. Spleen, pancreas, and adrenals.
   - D. Genitourinary organs and psoas shadows.
   - E. Gastrointestinal tract.

Films of good technical quality should be taken in one or several positions. The prone study of the abdomen is probably best for intestinal study, the upright position is helpful in searching for fluid levels and free peritoneal air, and the supine study is best for urinary tract examination. On the other hand, the anteroposterior view in the lateral decubitus with the right side up is one which has been too little appreciated and used. Free air in the peritoneal cavity, the properitoneal fat line with its occasional obliteration, and the differentiation among types of intestinal distention are a few of the phenomena demonstrable in this position. If only two views are to be taken, the authors advocate that they be the prone and the lateral decubitus. These two positions require little exertion on the part of an ill patient and at the same time yield maximum information. Wherever there is an x-ray table which can be tilted from the horizontal to the vertical position, the lateral decubitus film can be taken with the Bucky, the patient lying on a cart.

Of paramount interest to the surgeon is the gastrointestinal tract. The recognition of sigmoid volvulus, paralytic ileus, and colon obstruction from the plain scout film is discussed and illustrated.

Fourteen roentgenograms; 1 photograph.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

The Early Diagnosis of Carcinoma of the Stomach. Orville F. Grimes and H. Glenn Bell. California Med. **76**: 337–340, May 1952.

A significant improvement in the operative mortality for gastric cancer has been observed at the University of California Hospital. Upon analysis of the case histories of 540 patients operated upon in an eighteen-year period, it was noted that during the last five years covered by the series the mortality rate was 11.9 per cent as compared with 22.2 per cent during the earlier years. Nineteen and two-tenths per cent of these patients survived five years or more.

No typical pattern is discernible in the recorded symptomatology of gastric carcinoma. The patients may complain of various degrees and types of indigestion, dyspepsia, epigastric distress, anorexia, gaseous eructation, heartburn, easy fatigue, dysphagia, nausea, vomiting, hematemesis, malaise, and loss of weight. Roentgen study of the stomach suffices in at least 95 per cent of the cases to provide a diagnosis of carcinoma of the stomach. This high percentage, however, is merely evidence of the advanced state that the lesion has reached before precise methods of diagnosis are instituted. Periodic roentgen examinations are advisable for patients who have pernicious anemia, since certain changes in the gastric mucosa associated with that disease apparently predispose to the development of carcinoma. Patients who have histamine-proved gastric anacidity should probably undergo similar studies, since a significant number of them have atrophic gastric mucosa, which also seems to bear some relationship to cancer. In the event of equivocal or even negative roentgenologic findings in the presence of continued symptoms, direct inspection of the stomach by gastroscopy may provide evidence not obtained by any other method.

In recent years, the cytologic examination of gastric contents has provided a new means of obtaining an early diagnosis of carcinoma of the stomach. It is generally acknowledged, however, that 60 per cent is the maximum of diagnostic accuracy obtainable up to the present time by this method.

If the several investigative procedures yield equivocal results in the examination of the patient with a gastric ulcer, operation should be done immediately, for in such circumstances the patient should not be denied the certainty of diagnosis that can be obtained thereby.

Eleven roentgenograms; 1 photograph; 1 drawing.

HOWARD L. STEINBACH, M.D.
San Francisco, Calif.

Pneumoperitoneum in the Radiologic Diagnosis of Tumors of the Gastric Fundus. Vittorio Pricolo and Bruno Antoniazzi. Radiol. med. (Milan) **38**: 402–404, May 1952. (In Italian)

The authors have combined pneumoperitoneum with the usual barium examination to outline the inner and outer walls of neoplasms of the gastric fundus. The radiographs accompanying their paper show excellent visualization of these tumors. In 2 patients extension of the lesions to neighboring structures could be detected. Two patients were free from direct extension, but one of them was inoperable because of extensive liver metastasis. In 4 other patients extension of the tumors to the posterior wall could not be shown by this technic.

Four roentgenograms. CESARE GIANTURCO, M.D.
Urbana, Ill.

Phlegmonous Gastritis. Benjamin Miller and Harry Nushan. Am. J. Roentgenol. **67**: 781–784, May 1952.

Phlegmonous gastritis is rarely diagnosed clinically, since it occurs so infrequently and closely mimics acute pancreatitis, cholecystitis, pneumonia, and nephrolithiasis. Roentgenographically the lesion generally resembles neoplastic disease, though mucosal folds usually run through the involved area.

The disease is thought to be due to pyogenic infection of the stomach wall beginning in the submucosa and spreading toward the serosa. The mucosa is usually intact. If localized, the inflammation may be confined to the submucosa; if diffuse, the stomach wall is markedly thickened and the inflammation may extend to the peritoneal covering, at times perforating into the abdominal cavity. It is thought that the lesion is produced by contaminated foreign bodies, such as fish bones, penetrating the mucosa and depositing bacteria in the submucosa.

The case reported is that of a 42-year-old male who had abdominal pain, intermittent nausea and vomiting, and a considerable weight loss. Roentgen examination revealed elevation of the left diaphragm and a large irregular filling defect involving almost the entire cardia of the stomach. The appearance was that of neoplasm. Exploratory laparotomy revealed typical phlegmonous gastritis and no further surgery was done. The patient was treated with intravenous fluids and penicillin. Because he could take little nourishment by mouth and his veins were thrombotic, a jejunostomy was done seventeen days postoperatively. At that time the acute inflammatory process had quieted down. Gradual improvement followed, but about three and one-half months following the initial operation a rectal hemorrhage occurred, followed by death. Permission for autopsy was refused.

Three roentgenograms. BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Ferromagnetic Foreign Bodies Beyond the Pylorus: A Report of Two Cases in Which Successful Peroral Removal Was Accomplished by the Use of the Alnico Magnet. Alfred A. Dorenbusch. Arch. Otolaryng. **55**: 589–596, May 1952.

The author reports 2 cases in which an Alnico magnet was used for the peroral removal of foreign bodies, in one case a hatpin (6 cm. long) from the duodenum and in the other a 5-cm. nail from the jejunum. In each instance the position of the foreign body had remained unchanged during four days of observation. In 1948, Roberts (Laryngoscope **58**: 155, 1948) demonstrated the use of a carbonated beverage as a contrast medium for the localization of foreign bodies. In both of the author's cases this procedure helped to determine that the foreign body was beyond the pylorus.

No previous record of the peroral removal of a magnetic jejunal foreign body could be found.

Seventeen roentgenograms.

Acute Intestinal Obstruction in Infancy. Charles W. McLaughlin, Jr., and John D. Coe. Arch. Surg. **64**: 541–548, May 1952.

This report concerns some observations on the management of 53 infants with acute intestinal obstruction. Five different groups of conditions are considered: (1) duodenal obstruction, (2) small-bowel obstruction due to multiple causes, (3) intussusception, (4) incarcerated inguinal hernia, and (5) imperforate anus.

Duodenal obstruction was diagnosed in 12 patients who came to surgery at two to thirty days of age. Obstructions were due to congenital bands or adhesions, malrotation associated with malrotation of the colon, duodenal atresia, non-specific acute duodenitis, and circular pancreas. There were 2 deaths.

In 11 cases of lower small-bowel obstruction there were 7 deaths. The average age at surgery was seven and a half weeks. Obstruction resulted from congenital adhesions, volvulus, meconium ileus, and atresia. Film studies revealed small-bowel distention with fluid levels in all cases.

Nineteen cases of intussusception were studied, in which the average age at surgery was thirteen months. Diagnosis was based on barium enema examination but this was not used in an attempt at reduction. There were 3 deaths in this group and prognosis was found to depend on duration of symptoms before treatment. Reduction at surgery was done in 12 cases and resection in 7. The authors believe that if reduction cannot be accomplished in ten minutes it is better to proceed immediately with resection.

Seven instances of incarcerated inguinal hernia necessitating emergency reduction were seen. The patients averaged thirteen months of age. Diagnosis was based on the presence in the groin of a painful, irreducible swelling. There was no mortality.

Imperforate anus was encountered in 4 infants averaging twenty-six hours of age. Roentgen examination of the inverted infant was of value in estimating the length of the defect. In 2 of the cases the rectal pouch ended blindly above the pelvic peritoneum and colostomy was done.

Attention is directed to adequate hydration, anesthesia, and administration of blood in handling intestinal obstruction in infants. It is noted that in all cases the history is very limited and working information must be obtained from careful examination and competent x-ray assistance.

Four roentgenograms; 6 tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Functional Disorders of Small Bowel After Gastrectomy and Vagotomy: Correlation of Radiographic and Kymographic Studies. A. J. Glazebrook. Lancet **1**: 895–899, May 3, 1952.

Intestinal motility was studied in 50 patients with various abdominal symptoms after partial gastrectomy, with and without vagotomy. Intrajejunal balloon kymography and roentgenography after a dextrose-barium meal revealed many types of small-intestinal dysfunction, any of which may cause symptoms as follows:

Intestinal Torpor: Constipation, with dull aching abdominal pains.

Intestinal Hurry: "Dumping" symptoms after food (especially sweet, liquid, and bulky meals), frequent bulky pale stools, and loss of weight, sometimes progressive.

Intestinal Spasm: Colicky abdominal pain (at times severe enough to suggest stomal ulcer) with or without "dumping" symptoms after food; constipation.

Combinations of these motor disorders, such as spasm followed by hurry, or spasm followed by torpor, are more common than any type alone.

Four roentgenograms; 7 kymographic tracings.

Duodenal Obstruction from a Gallstone. Review and Report of a Case. C. F. Broderick. Wisconsin M. J. **51**: 371–372, April 1952.

A case of duodenal obstruction by a gallstone passing through a cholecystoduodenal fistula is reported. Roentgen examination with a thin mixture of barium disclosed within the lumen of the duodenal bulb a round object about 4 cm. in diameter, showing concentric lines of calcification. The preoperative diagnosis of gallstone obstruction and an associated fistula was confirmed at surgery.

One roentgenogram; 1 photograph.

Small Lesions of Colon: Importance of Cooperation Between Surgeon and Roentgenologist in Diagnosis and Treatment. Foster L. McMillan and Robert M. Potter. Arch. Surg. **64**: 686–695, May 1952.

Effective treatment of carcinoma of the large intestine presupposes early diagnosis. Surgical treatment has an encouraging survival rate and is associated with low morbidity and a low operative mortality.

The intimate relationship of adenomatous polyps to carcinoma is well established. These polyps are considered true tumors and have been shown to be premalignant. Probably more than 15 per cent of cancers of the colon and rectum have their origin in polypoid lesions.

Sixty to 70 per cent of polypoid lesions of the rectum and colon are within reach of the 25-cm. proctosigmoidoscope and lesions less than 5 mm. in diameter can frequently be seen. The radiologist makes no claim to effective visualization of this area. The detection of the remaining 30 to 40 per cent of lesions of the colon, however, is his responsibility. The higher incidence of malignant change in polyps of the more proximal portions of the colon emphasizes the importance of their early detection.

In the discovery of small colon lesions interest is centered on contrast within the bowel rather than contrast between the bowel and surrounding tissues. The authors advise the use of dilute barium solution, 130 c.c. to the liter. The colon is filled under fluoroscopic control and roentgenograms are made with an attempt to avoid overlap of the different portions. Films are then examined while the patient evacuates. After the postevacuation films are made, the patient is again examined with special attention to any suspicious areas in the refilled colon. Pressure films are obtained where indicated. Any area of decreased density which is duplicated on films before and after evacuation is considered to be a lesion attached to, or a part of, the colon wall. Most pedunculated polyps which shift position have a pedicle long enough to be demonstrated. Prior to surgery, the radiologist should review films with the surgeon in order to indicate size and location of lesions and to point out any suspicious but unconfirmed lesions.

It is not feasible to attempt such exhaustive study routinely, but certain situations demand a complete proctologic and roentgenologic examination. One of these indications is the presence of one or more of the following *unexplained* signs or symptoms: secondary anemia, persistent or changing bowel function, abdominal pain or cramps, a palpable abdominal tumor. Another is a history of rectal bleeding without adequate explanation after proctoscopic examination.

When proctosigmoidoscopic examination reveals one or more polypoid lesions, careful search of the colon by barium enema is indicated, since a high percentage of these lesions are multiple. When carcinoma of the rectum or rectosigmoid is discovered by proctoscope, search of the remainder of the colon should be done by contrast study for the same reason, *viz.*, the tendency to multiplicity of polypoid lesions and areas of malignant degeneration in them. In addition, after removal of polyps by proctoscope or after surgical removal by resection, follow-up is necessary for an indefinite period, due to the tendency to recurrence.

Seven illustrative case reports are presented which cover the salient features outlined above.

Seven roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

Diverticulitis of the Sigmoid Colon. Frank J. McGowan and William I. Wolff. Gastroenterology **21**: 119–132, May 1952.

Diverticulosis of the colon is predominantly a disease of older patients, being most common between fifty-five and sixty years. It is seen mainly in the sigmoid portion. It is generally agreed to be an acquired condition but with a congenital predisposition. Increased intraluminal pressure associated with weak musculature at certain points in the bowel wall promotes herniation of mucosa through the muscle layer. The wall of a diverticulum is composed of atrophic mucosa, submucosa, and serosa.

Without musculature to aid in evacuation, these pockets become filled with inspissated fecal material, undergo local erosion and infection, and become blocked

off at the narrow neck by edema and inflammation. This condition constitutes a diverticulitis, which may be overcome by bodily defense processes or progress along any one of a number of pathways.

Progression may be chronic and accompanied by chronic inflammatory changes leading to obstruction from regional colospasm or hyperplastic organic changes. Acute attacks may subside only to recur with increasing frequency. There may be perforation into the peritoneal cavity with a resultant diffuse peritonitis or the perforation may be walled off, causing adhesions and secondary obstructive phenomena. An abscess may develop. Further penetration may then occur, with production of a variety of colic fistulas.

Roentgenographic study will reveal diverticula in most instances. The roentgen signs of diverticulitis are an area of persistent local spasm or more advanced organic changes denoted by stenosis, rigidity, mucosal alterations, serration of the wall, constant extrinsic pressure defects, or extravasation of contrast medium outside the lumen of the bowel. Clinically acute diverticulitis may show no roentgen signs; conversely, signs of inflammation noted on barium enema may be found in patients free of symptoms. In addition, there is a rather remarkable reversibility of apparent high-grade stenosis demonstrable radiologically following diversionary colostomy or even medical management.

Cancer when seen in diverticulosis is probably coincidental. A constricting diverticular lesion may be difficult to differentiate from carcinoma. Even at surgery it may sometimes be impossible to rule out a malignant process.

Uncomplicated diverticulitis of the sigmoid is generally best managed by conservative means. Complicated acute diverticulitis is an indication for surgery. Colostomy should always precede any attack on the fistular complications. Closure of such a colostomy without definitive resection of the diseased segment frequently leads to recurrence of the disease and its complications. One-stage end-to-end resection of the involved sigmoid has become a safe procedure and is the choice where acute exacerbations can be made to subside without recourse to fecal stream diversion.

Six illustrative cases are reported.

Seven roentgenograms; 1 photograph; 1 graph.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Reduction of Intussusception by Barium Enema. Mark M. Ravitch and Russell H. Morgan. Ann. Surg. **135:** 596–604, May 1952.

Many surgeons oppose hydrostatic reduction of intussusception by barium enema. The bases for such opposition include the possibility of an erroneous conclusion that reduction has occurred, possible reduction of gangrenous bowel, danger of rupture of the intestine, and the chance of missing a specific causative lesion such as a polyp. All of these arguments are satisfactorily met.

Hydrostatic pressure reduction is definitely less traumatic to the bowel than manual reduction. Mechanical obstruction from adhesions has been frequently reported after open reduction, but never after enema reduction. It is to be feared, according to the authors, that "resection is not rarely demanded by the pathologic changes induced by the manipulative reduction rather than by the intussusception itself."

Reduction with barium enema, under fluoroscopic control, is not a blind procedure. Accurate diagnosis of the presence of an intussusception can be made. In the authors' experience, with no more than 3 1/2 feet of hydrostatic pressure and avoidance of manipulation, reduction of gangrenous bowel or rupture of the bowel has not occurred. The burden of the hydrostatic pressure is borne by the healthy bowel of the intussuscipiens.

Intussusception may recur after operation as well as after barium enema reduction. The slightly lower incidence in the surgical cases is due to postoperative adhesions, which carry their own penalty in the appreciable number of cases of obstruction developing months or years later.

In a series of 180 intussusceptions in infants and children treated at the Johns Hopkins Hospital since 1889, only 11 specific lesions were found. It seems reasonable, therefore, to withhold operation until recurrence and then to seek for a possible focal lesion. Of 57 intussusceptions treated primarily by barium enema, 42 were successfully reduced; in 15, operation was required to complete the reduction. There were 3 recurrences in the entire series, all of which were reduced by enema.

The authors mention the Johns Hopkins fluoroscopic screen intensifier (see Radiology **57:** 556, 1951) which has made it possible to obtain motion pictures of barium enemas with no more radiation than is employed in conventional fluoroscopic technics.

Twenty-three roentgenograms; 1 drawing; 1 photograph.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Oriented Pneumatic Compression of the Gallbladder. Information Supplementing that Obtained by Routine Cholecystography. J. Andreani. J. de radiol. et d'électrol. **33:** 255–260, 1952. (In French)

By means of pneumatic compression in the prone position, the gallbladder may be more clearly visualized. Gallstones are revealed with greater clarity. "Pseudo" gallstones are ruled out, with the pressing away of intestinal shadows. Other morphologic and physiologic aspects of the gallbladder and bile ducts are also more clearly demonstrated. The method of compression is comparable to that currently used in urography.

Ten roentgenograms.

CHARLES M. NICE, M.D.
University of Minnesota

Aberrant Pancreas: A Cause of Duodenal Syndrome. Maurice Feldman and Tobias Weinberg. J.A.M.A. **148:** 893–898, March 15, 1952.

In a study of 410 consecutive autopsies the authors found an unusually high incidence of accessory pancreas in the duodenum (13.7 per cent). The usual site is the second portion of the duodenum in the area of the pancreatic anlagen. Grossly the aberrant nodules appear as firm, irregular elevations or well defined circumscribed nodules. Their growth must be extremely slow, since the vast majority measure less than 1 cm. in diameter. Multiple accessory pancreatic nodules are frequently observed.

The average age of the adults with autopsy proof of aberrant pancreas was sixty years; most of the 22 children were less than two weeks of age. One infant was stillborn.

Symptoms produced by an aberrant pancreas are

usually the result of complications and most often simulate peptic ulceration, cholecystitis, carcinoma, or obstruction.

Many of these cases are overlooked because of the lack of detailed roentgenologic study and diagnostic criteria. A presumptive diagnosis of aberrant pancreas of the duodenum can be made by demonstration of a smooth polyp-like filling defect. The nodules, however, are frequently too small to be shown on the roentgenogram. A detailed study of the duodenum may reveal mucosal folds which may be compressed, distorted, flattened, or effaced in the involved area. The polyp-like nodular defect is persistent on compression spot roentgenograms.

The authors conclude that when a nodular polyp-like growth is observed in the second portion of the duodenum without clinical manifestation, the best procedure is re-examination at frequent intervals, with surgery being considered only as a last resort.

Two roentgenograms; 1 drawing.

ROBERT H. LEAMING, M.D.
Memorial Center, New York

Pancreatic Calcifications. Kenneth E. Lemmer and Erwin R. Schmidt. Arch. Surg. **64**: 571–577, May 1952.

Pancreatic calcifications may be classified into two groups: (1) true calculi in the ducts, (2) diffuse calcinosis, with deposits of calcium scattered throughout the gland. The calcifications are thought to be a late phase of chronic relapsing pancreatitis and may be associated with fibrosis of the gland, diabetes, and steatorrhea. Pancreatic cysts are more common following an acute pancreatitis.

Forty cases of pancreatic calcification were seen in the University Hospital (Madison, Wis.) from 1935 to 1951. Ten of the patients had no symptoms referable to the pancreas. In this group the calcifications were found either on routine x-ray study or at autopsy. The remaining 30 were admitted to the hospital complaining of abdominal pain and the diagnosis was either made or confirmed roentgenologically.

The authors present here the histories of 8 patients with evidence of pancreatic calcifications on roentgen examination and severe, intractable upper abdominal pain. All were subjected to unilateral or bilateral supradiaphragmatic sympathectomy or splanchnicectomy. Of the 8 patients, 4 were free of pain three months to three and a half years after operation. Three of the remaining 4 had various degrees of recurrent pain. Addiction to morphine in this group clouded possible beneficial effect of surgery.

Histologic proof of the underlying pathology in the region of the pancreas in these cases is not supplied. The association with chronic pancreatitis is based on autopsy evidence in other cases. As pointed out in the discussion of this paper, however, the possibility of calcifications arising in tissues in the area outside the pancreas should be considered. Calcifications may lie in lymph nodes, and some other disease process may be responsible for the symptomatology. Carcinoma of the pancreas may cause a different kind of pain but should always be thought of in a patient with severe and intractable upper abdominal or lumbar pain.

Four roentgenograms; 1 table.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Double Gall Bladder. Diagnosed by Cholecystography and Confirmed at Operation. Lloyd Cameron. Australian & New Zealand J. Surg. **21**: 308–309, May 1952.

In a patient with symptoms of gallbladder disease, cholecystography showed two superimposed gallbladders with two stones in the lower one. At surgery the roentgen findings were confirmed. Each gallbladder had its own cystic duct, the two entering the common duct a centimeter apart.

One roentgenogram; 1 drawing.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Value of Cholangiograms During Biliary-Tract Surgery. Donald Hight and James R. Lingley. New England J. Med. **246**: 761–765, May 15, 1952.

Except in few instances, accurate examination of the common duct should be a part of every operation on the extrahepatic biliary tract. Cholangiography was first suggested by Cotte in 1929 (Bull. et mém. Soc. nat. de chir. **55**: 863, 1929) and a high degree of accuracy in the discovery of stones of the common duct overlooked at operation has been attained.

The technic for cholangiography at the Worcester (Mass.) Memorial Hospital is described. The procedure is carried out in the operating room, using a tonsil-type needle and injection of Diodrast after the gallbladder has been freed and the cystic duct and its junction with the common duct have been dissected out. Seven cubic centimeters of Diodrast diluted with 3 c.c. of saline is used, since small stones are likely to be obscured by the undiluted medium. The film is developed immediately and if there are no stones the needle is removed and the cystic duct is ligated. When evidence of stones or disease is found, the common duct is explored.

In a series of 115 cholangiograms the authors found 27 positive and 78 negative. Two errors were discovered later by postoperative cholangiography, which revealed stones.

Although not infallible, operative cholangiograms permit the radiologist to make a highly accurate interpretation. The information is of great value in avoiding needless exploration of the common duct.

Seven roentgenograms; 1 photograph.

FRANK T. MORAN, M.D.
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THE MUSCULOSKELETAL SYSTEM

Generalized Decreased Bone Density. David M. Gould. Am. J. M. Sc. **223**: 569–580, May 1952.

This paper, appearing under the heading "Progress of Medical Science," is in the nature of a review of generalized decreased density of bone as demonstrated roentgenologically. Such a change may be the result (1) of diseases causing a disturbance of mineral metabolism, the so-called malacic diseases, or (2) of diseases producing a disturbance in the development of the osteoid tissue, namely, the porotic diseases. The malacic diseases include rickets, osteomalacia, osteonephropathy, hyperparathyroidism, and idiopathic hypercalcuria. The porotic group is made up of disuse atrophy, scurvy, osteogenesis imperfecta, Cushing's syndrome, senile osteoporosis, postmenopausal osteoporosis, and hypoparathyroidism.

GENERALIZED DECREASED BONE DENSITY

	Rickets	Scurvy
1. General appearance of long bones	Coarse demineralization A "fibrous effect"	Ground glass Washed out effect
2. Plasticity	Softening	Brittleness
3. Reaction to trauma and stress	Bowing Greenstick fractures Widening and cupping of metaphysis	Infractions Dislocation of epiphyses and plate Corner sign
4. Cortical or compact bone	Absent or diminished Subperiosteal resorption	Thin but clear Endosteal resorption
5. Cancellous or spongy bone	Primary trabeculae, remaining secondary trabeculae resorbed Preferential reaction to Wolff's law	Primary and secondary resorbed No reaction to Wolff's law
6. Osteoid overgrowth	Osteoid cysts (rare) Provisional zone of calcification radiolucent Epiphyses—coarse, radiolucent but growing No cortical edge	None Not formed Do not grow. Fine, radiolucent. Edge present. Ring sign. Wimberger
7. Subperiosteal hemorrhage	None	± present
8. Costochondral junctions	Rachitic rosary Costochondral junction	Bayoneting of ribs Infractions
9. Skull	Bossing—thin Hot cross bun, coarse	No change
10. Mandible	Coarse	Ground glass
11. Teeth and surrounding	No lamina dura	Lamina dura thin but distinct

Each of these two groups is discussed at length, and tables are presented listing the roentgen findings. Finally, taking rickets and scurvy as the prototypes for differentiation of osteomalacic and osteoporotic diseases, the author has constructed a table (reproduced above) showing the distinguishing radiological changes.

Interesting Bone Changes in Plain Urograms. W. L. Fitzgerald and M. D. Thomas, Jr. J. Urol. **67**: 547–556, April 1952.

The purpose of the paper is to give the urologist, in a condensed form, (*a*) some of the important fundamental considerations prerequisite to proper identification of bone lesions; (*b*) the classic appearance of some of the bone lesions which might present themselves on a plain urogram; (*c*) additional data which may be needed to substantiate the clinical diagnosis of such lesions.

Bone metabolism is discussed shortly and it is pointed out that alkaline phosphatase is produced during osteoblastic activity. Acid phosphatase is produced only by the tissues of the prostate gland and the enzyme is released into the blood stream in significant amounts with the extension of prostatic carcinoma through the prostatic capsule.

A number of diseases were chosen for discussion, and the important data on each are tabulated.

Senile Osteoporosis: General osteoporosis of the spine and pelvis is demonstrable on the plain urogram. The skull and extremities are said to be less frequently affected. As this condition is apparently due to failure of osteoblastic activity, there is no significant change in the blood chemistry.

Hyperparathyroidism: The classical radiological features are presented. The most constant chemical findings are hypercalcemia, hyperphosphatemia and hypercalcuria. The serum alkaline phosphatase is elevated in all cases with bone involvement.

Paget's Disease: This disease is important to the urologist because it may be confused with metastatic carcinoma of the prostate. Distinguishing features, in addition to the appearance on the plain urogram, are the typical skull involvement, sabre shin, normal acid phosphatase, and very high serum alkaline phosphatase.

Multiple Myelomatosis: Bone lesions in this disease may vary, but the typical finding is small punched-out osteolytic areas of flat and irregular bone. The diagnosis is confirmed by marrow studies, Bence-Jones protein in the urine, and reversed A-G ratio.

Metastases from the thyroid, breast, kidney, and lung, usually osteolytic, may appear on the plain urogram. There is usually nothing characteristic in the blood chemistry in these cases. Metastases from the prostate are predominantly osteoblastic, though mixed types and osteolytic lesions may occur. The serum acid phosphatase is raised in 85 per cent of cases of carcinoma of the prostate, with bone metastases.

Fourteen roentgenograms; 7 tables.

MARTHINUS J. VAN DER WALT, M.D.
University of Pennsylvania

Morphology of Turner's Syndrome. H.-W. Wedler and A. Welsch. Fortschr. a. d. Geb. d. Röntgenstrahlen **76:** 586–591, May 1952. (In German)

By tracing 117 relatives scattered over 6 generations in a suspected family, 13 instances of Turner's syndrome were uncovered. Nine individuals exhibited sufficiently characteristic signs in two or more of the four regions usually involved to be tabulated in this report.

Hereditary structural changes in the nails, the elbow joint, the knee joint, and the pelvis constitute the regional morphology of this syndrome. Nail changes consist of either aplasia or hypoplasia, particularly of the thumb and index finger. Clinically one finds limitation in motion of the elbow joint plus an increase in the carrying angle. On the roentgenogram this is seen to be due to poor development of the capitulum, irregular formation of the radial head, and a tendency to early hypertrophic arthritis. Knee joint changes are the most constant of all. The defectively calcified, hypoplastic patella, the laterally displaced patella, and the asymmetric development of the condyles explain the clinically discernible disturbance in gait. Recently attention has centered upon pelvic horns. These knobs of bone, which project from the posterior aspect of the iliac wings, are typical of Turner's syndrome. Additional pelvic changes include wing-like ilia with outwardly pointing anterior superior spines, anthropoid inlet in the female, and exaggerated lumbar lordosis.

This disorder is hereditarily dominant, non-sex-linked, and familial. Onychochondrodysplasia, onycho-arthro-osteodysplasia, and osteo-onychodysplasia are the rather cumbersome terms that have been applied to this ailment. The eponym "Turner's syndrome" is in reference to John W. Turner, who in 1933 first described this entity under the title "Hereditary Arthrodysplasia Associated with Hereditary Dystrophy of the Nails" (J.A.M.A. **100:** 882, March 25, 1933).

Sixteen roentgenograms; 1 table.

WM. F. WANGNER, M.D.
Royal Oak, Mich.

The Osteoporosis of Immobilisation in Recumbency. F. Harwood Stevenson. J. Bone & Joint Surg. **34-B:** 256–265, May 1952.

This paper is based upon studies made on 85 patients during five years. All had been or were being immobilized without suspension for at least three months, a large proportion for one or more years. The series included cases of tuberculosis of the hip, knee, spine, ankle, and tarsus, traumatic synovitis of a knee, Still's disease of the hip or knee, rheumatoid arthritis, osteomyelitis of the femur, and anterior poliomyelitis. Fourteen patients were under five years of age, 39 between five years and the age of epiphyseal fusion, and 32 were adults.

Increased excretion of sulfur, nitrogen, phosphorus, and calcium by immobilized patients has been demonstrated in the past. The author now discusses the widespread effects of immobilization upon the skeleton; the additional effect of immobilization and recumbency in patients with diseases of long standing in whom porosis has not previously developed; the uniformity of these changes in the lower limbs, whatever the reason for the immobilization; and the fact that immobilization is the only factor common to the various situations where the effects are found.

Prolonged immobilization, even when the limbs are free from disease, produces gross osteoporosis in the lower limbs, which illustrate the disturbed calcium metabolism. Ambulatory patients have been seen in whom tuberculous arthritis is known to have existed for months or years without producing osteoporosis. A few weeks or months of immobilization resulted in gross osteoporosis in regions remote from the infective disease and also at the site of the tuberculous lesion itself. The essential part played by immobilization in producing the radiographic picture in the group studied is proved by the precisely similiar patterns seen throughout the leg above a diseased tarsus, below a diseased hip, or in the other limb that has been immobilized; by the occurrence of the same changes in both legs even when disease is limited to the spine; and by the uniformity of the picture following immobilization for tuberculous arthritis, Still's disease, rheumatoid arthritis, and traumatic synovitis.

The pattern common to all age groups includes a generalized decrease of bone density, a zone of more intense porosis at the metaphysis, a narrower zone immediately deep to the cortex of bone ends, and further irregularly distributed patches. In some cases of tuberculosis the loss of cancellous bone may be due far more to mechanical disintegration during the state of intense porosis than to destruction by tuberculous granulation tissue. This indicates the importance of obtaining the benefit of local rest without an intense negative calcium and nitrogen balance.

The author discusses also some secondary deformities from immobilization osteoporosis. These include flattening of the chest in children who are kept on their backs over a period of months, fractures due to minor trauma, and coxa valga.

Fourteen roentgenograms; 1 photograph; 3 tables.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Pseudohypoparathyroidism: Report of a Case Showing Bony Demineralization. Telfer B. Reynolds, George Jacobson, Hugh A. Edmondson, Helen Eastman Martin, and Clarence H. Nelson. J. Clin. Endocrinol. & Metab. **12:** 560–573, May 1952.

The case of a 29-year-old male Negro with pseudohypoparathyroidism is presented. This is the thirteenth such case to be reported. The patient was mentally retarded and had at least one epileptic attack. He exhibited, also, the typical changes in the chemistry of the blood, tetany, cataracts, calcification in the basal ganglia, skin calcification, delayed eruption of the permanent teeth, and slight shortening of the metacarpals. Considerable bony demineralization was evident, particularly in the long bones, pelvis, spine, and feet. Parathormone was without measurable effect on calcium or phosphorus metabolism. Possible mechanisms for the bony demineralization, which is a rela-

tively unusual finding, are discussed, but no definite conclusions are reached.

Four roentgenograms; 2 photographs; 2 tables.

Some Radiological Aspects of Tuberculous Disease of Bones and Joints. Brian E. Frecker. M. J. Australia **1**: 606–608, May 3, 1952.

In skeletal as in pulmonary tuberculosis it is rarely possible, early in the process, to make a positive diagnosis on the basis of a single x-ray examination. The tuberculous process has certain characteristics which influence the roentgen picture. The most important is the chronic progressive nature of the disease. It is this slowly continuing development and the relative rate of development of the various features that usually clinch the diagnosis. It is for this reason that serial x-ray studies are of such importance.

Lesions of bone, whether or not they accompany a joint lesion, are in general characterized by a slowly progressive destruction, which will usually continue for at least a month or two despite any treatment. The major features of the bone involvement may be listed as follows: (1) long course and slow recovery; (2) little if any sclerosis; (3) little if any periostitis; (4) sequestra infrequent and small; (5) penetration of cartilage barriers; (6) formation of calcifying abscesses. Not all of these features are evident in any one case, but they represent the fundamental guiding principles, the hallmarks of the disease.

It is for the most part impossible roentgenologically to decide whether a tuberculous lesion involving a joint originated in that joint or in an adjacent bone. However, when the involvement of the joint is the outstanding feature of the disease, the sequence of events tends to follow a certain pattern, the salient points of which are as follows: (1) continuous development of (*a*) effusion into the joint and (*b*) decalcification; (2) after some months (*a*) destruction of adjacent bone and (*b*) thinning of joint space; (3) after some years, ankylosis.

When a joint is involved, healing is accompanied in the vast majority of cases by ankylosis, fibrous or bony. Bony ankylosis is revealed roentgenographically by the continuity of bone trabeculae across the joint. This is usually recognized readily, but sometimes several views are necessary to insure that the appearance of ankylosis is not produced by overlapping bone shadows. Another evidence of healing is the return to normal of the calcium content of the parts and the re-establishment of a clear and sharply defined cortical and trabecular pattern. An irregular widening of the trabecular network remains, usually for life.

Sometimes, despite all other evidence indicating quiescence, rarefied areas will persist. In these cases an absence of any change over at least two years should be demonstrated before the lesion is pronounced healed.

Seven roentgenograms.

A Clinical Study of Bone Lesions in Malignant Lymphoma. James H. Taylor. J. Iowa State M. Soc. **42**: 214–218, May 1952.

Gross skeletal changes were demonstrated roentgenographically in 29 of 276 cases of malignant lymphoma seen at the State University of Iowa Hospitals during a twelve-year period. Twenty-three of the patients showing skeletal involvement were suffering from Hodgkin's disease, 5 had lymphocytic (or lymphoblastic) lymphoma, and 1 had a reticulum-cell sarcoma.

The roentgen appearance of the lesion is not diagnostic; it may resemble almost any other type of bone involvement. In general the lesions were irregular with patchy areas of destruction, often with varying degrees of reactive new bone formation. Periosteal reaction or cortical expansion with central destruction was fairly common. Pathological fractures of the ribs and vertebrae with partial collapse occurred in some cases. The intervertebral disks were usually preserved. Fractures of other bones were rare. The absence of fractures of long bones in Hodgkin's disease was attributed to the low incidence of involvement of these bones other than the femur. In a few cases of Hodgkin's disease the changes appeared to consist solely of diffuse new bone formation. In others there was only a vague moth-eaten appearance. Occasionally different types of lesions were found simultaneously in the same patient. In the author's series all of the lesions of lymphocytic lymphoma were destructive.

In a few cases bone lesions preceded the systemic manifestations of the disease. There was no relationship between skeletal involvement and the clinical course.

Roentgen irradiation or the administration of nitrogen mustards relieved pain for variable periods, but healing of bone lesions did not occur.

Seven roentgenograms; 2 tables.

Spontaneous Demonstration of the True Joint Space. L. Kliemann. Fortschr. a. d. Geb. d. Röntgenstrahlen **76**: 602–606, May 1952. (In German)

The so-called vacuum sign is occasionally visualized where it outlines the true joint space. One may also see it in the intervertebral disk, in which place it indicates disease. Only rarely is a spontaneous vacuum observed in the knee, although Dittmar has reported it in children upon application of strong pull. The author here presents 4 cases in which the vacuum sign was noted as a spontaneous event in the knee. All 4 patients were middle-aged males, in all the sign was bilateral, and all had pain in the knees unrelated to trauma. The vacuum persisted for several weeks, after which it disappeared, with the subsidence of symptoms. One could see the vacuum both in films taken horizontally and in those made in weight-bearing. It is hypothesized that the sign is caused by a shrinkage and constriction of the medial meniscus dependent upon the aging process. It is considered pathological.

Three roentgenograms; 1 graph.

WM. F. WANGNER, M.D.
Royal Oak, Mich.

The Functional Roentgen Study of the Cervical Spine. H. Junghanns. Fortschr. a. d. Geb. d. Röntgenstrahlen **76**: 591–594, May 1952. (In German)

Although in many instances routine cervical spine views demonstrate the disease process, occasionally films must be obtained with the neck in forward and backward flexion in order to clarify the picture. Junghanns shows a disk degeneration of the fourth cervical segment which could not be diagnosed on the routine lateral view. On the lateral film taken during flexion of the head, however, it was possible to see loss of normal curvature at the level of C4, reduction in the height of the C4 intervertebral disk, and changes in the relationships of the zygo-apophyseal joints.

Three roentgenograms. WM. F. WANGNER, M.D.
Royal Oak, Mich.

Nontraumatic Cervical Dislocations in Rheumatoid Spondylitis. Daniel Kornblum, Mack L. Clayton, and Henry H. Nash. J.A.M.A. **149:** 431–435, May 31, 1952.

Hyperemia, capsular distention, and ligamentous relaxation, all of which are present in the active stage of rheumatoid arthritis, are etiologic factors in spontaneous cervical dislocations. Such dislocations, whether involving the atlantoaxial joint or the lower cervical spine, should be recognized as non-traumatic concomitants of rheumatoid spondylitis. Vigorous early treatment can prevent fixed deformities and relieve signs and symptoms of spinal cord compression.

The radiological evidence of atlantoaxial dislocation is quite definite. The abnormal forward position of the anterior arch of the atlas in relation to the odontoid produces an angulation of the normal posterior limits of the spinal canal. Abnormal inclination of the atlas also brings its posterior arch closer to the occiput. In addition, the films show rheumatoid arthritic involvement of the various cervical articulations.

Lower cervical dislocations will be revealed by anterior displacement of one vertebral body in relation to another and deossification in the articular facets, sometimes with subsequent recalcification.

Varying degrees of cord involvement are mentioned in reported cases, ranging from minor neurologic changes to quadriplegia. Symptoms are usually absent when the dislocation is unilateral. With bilateral dislocations, as in 2 of the 4 cases presented by the authors, possible spinal cord injury assumes importance. In these 2 cases relief of radiating arm pain and paresthesia during treatment was dramatic.

Manipulation under anesthesia, fixation in a plaster jacket, and head traction are among the measures recommended.

Seven roentgenograms; 1 photograph.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

Roentgenologically Detectable Changes in the Lumbar Spinous Processes and Their Significance in the Pathogenesis of Backache. W. Schumann and J. Trautmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **76:** 579–586, May 1952. (In German)

Of the many patients who present themselves with complaints of low back pain, a small group may be separated on the basis of a characteristic history associated with definite x-ray findings. A patient from this group describes a sudden onset of back pain, or lumbago, as the result of hyperextending the spine following a period of long sitting or of carrying a burden. Physical examination reveals tenderness over the lumbar spinous processes, with regional muscle spasm. A clinical picture such as this suggests the ailment variously described as diarthrosis interspinosa, osteoarthrosis of the spinous processes, osteoarthrosis interspinosa, Baastrup's disease, and in the English literature as "kissing spine."

The basic roentgen sign of this disease is impingement of the spinous processes of two or more of the lower lumbar vertebra. In addition, one may see bone sclerosis, loose body formation, ligamentous calcification and ossification, and hypertrophic spurring. In advanced cases there is flattening of the impinging portions of the processes with the development of pseudarthroses. When calcification is noted, the ligaments likely to be involved are the supraspinous, the interspinous, and the interarcuate. As a cause of kissing spine the authors particularly emphasize occupations in which weight-bearing is undertaken while the lumbar spine is held in exaggerated lordosis. Increased lumbar lordosis of any type, direct trauma, adiposity, intervertebral disk degeneration, and Paget's disease have been related in certain instances.

Four cases are reported in detail. It is mentioned that on the routine lateral lumbar spine roentgenograms the spin ousprocesses are commonly blacked out. Technic should be adjusted to correct this. Furthermore, views with the spine in ventral and dorsal flexion may be of value.

Seven roentgenograms; 4 drawings.

WM. F. WANGNER, M.D.
Royal Oak, Mich.

Nucleography. Peter R. Erlacher. J. Bone & Joint Surg. **34-B:** 204–210, May 1952.

In an experimental study of 200 intervertebral disks removed at necropsy, it was found that when the normal nucleus pulposus was injected directly with such dyes as eosin or methylene blue, the stain showed up only in the nucleus pulposus mass. The annulus took the stain only when, as a consequence of its degeneration, there were fissures and ruptures directly connected with the nuclear cavity. Larger ruptures were frequently filled with the nuclear mass, which could therefore be shown. Thus the spreading nucleus and its channel of diffusion were made visible, though the nuclear mass alone was stained. When radiopaque material was injected in this manner the radiographic findings agreed with those found with the above-described staining technics. In no instance were deposits of stain found in a healthy or only slightly degenerated annulus fibrosus.

Five principal disk-forms were apparent. "*Form 1*—The globular nucleus, found mostly in young subjects, denotes a healthy disc without degeneration or herniation. *Form 2*—The lobed nucleus, the usual form in adults, shows a few large lobulations. Herniation or protrusion is unlikely. *Form 3*—The simple branched nucleus shows a central shadow with a few long and narrow branches and predisposes to herniation. Frequently a visible protrusion if not a real herniation or a free prolapse can be diagnosed. *Form 4*—The multiple branched nucleus has a small central shadow and several branches in various directions. This is a transitory form of degeneration in which prolapse is likely to occur. *Form 5*—The spread nucleus shows multiple branches in all directions instead of the central shadow. This form represents the typical degenerated disc and is mostly associated with narrowing of the disc. Herniation must no longer be expected." These five types are diagrammatically illustrated.

The author describes his procedure for injecting the disks and the roentgen technic. The lumbar puncture needle is inserted so that the vertebral foramen is bypassed at its lateral angle and the disk is reached paradurally. The same needle is then pushed into the center of the nucleus and the opaque medium injected. Roentgenograms are taken in anteroposterior, lateral, and right and left oblique projections, with the patient turned at an angle of 15 degrees. The oblique views show lateral prolapse most distinctly.

Twelve roentgenograms, photographs, and diagrams.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Anterior Herniation of a Ruptured Lumbar Intervertebral Disk. Comments on the Diagnostic Value of the Diskogram. Ralph B. Cloward. Arch. Surg. **64**: 457–463, April 1952.

Diskography with direct visualization following Diodrast injection is described by the author as the best method of diagnosing anterior and unusual rupture and herniations of intervertebral disks. It consists in direct puncture of the disk through the spinal canal and injection of a water-soluble radiopaque substance, usually 35 per cent Diodrast, into the disk proper. Only 0.5 c.c. of the medium can be forcibly injected into a normal disk, and the x-ray study will show this material confined to the small, spherical, centrally placed nucleus pulposus. If, however, the disk has been ruptured, with a complete tearing and disorganization of the fibers of the annulus fibrosus and collapse of the disk, 2.0 or 3.0 c.c. of the medium can be easily injected and will be seen roentgenographically to be diffused throughout the intervertebral space.

It is suggested that anterior herniations may occur more frequently than previously recognized. Failure to identify and remove all the torn and loose fragments of the ruptured disk is blamed for most of the operative failures. The author describes his technic of exposure and fusion following thorough removal of the disk. A case is also reported.

Five roentgenograms; 1 photograph.

ALLIE WOOLFOLK, M.D.
Pittsburgh, Penna.

Intraspinal Lesions Masquerading as Protruded Lumbar Intervertebral Discs. Winchell McK. Craig, Hendrik J. Svien, Henry W. Dodge, Jr., and John D. Camp. J.A.M.A. **149**: 250–253, May 17, 1952.

Because of the difference in length between the spinal cord and the vertebral axis, nerve roots from the lumbar portion of the cord begin at the level of the 10th, 11th, and 12th thoracic vertebrae. They take an oblique course of varying length before making their exit through the intervertebral foramina. Tumors of the spinal cord, particularly those that are intradural and extramedullary or extradural, can be so situated in relation to the lumbar nerve roots that a clinical picture indistinguishable from that of protruded disk is produced. The tumor can originate at the level of the 10th thoracic vertebra or lower. The location of the lesion, and in most cases its nature, can be determined by analysis of the spinal fluid and by contrast myelography.

Of 1,296 patients operated on at the Mayo Clinic for intraspinal lesions at the level of T10 or lower, 51 had spinal cord tumors. Twenty-seven of these had a preoperative working diagnosis of protruded intervertebral disk, and in 20 of this number, contrast myelography established the correct diagnosis of intraspinal tumor. Criteria for differential diagnosis by myelography have been discussed by Camp (Radiology **54**: 477, 1950). Elevated total protein content of the cerebrospinal fluid is an important feature of spinal cord tumors. The authors consider the lesion a tumor until proved otherwise if the level is 100 mg. or more. Among the clinical symptoms which warrant a suspicion of tumor are: (1) radicular pain at night; (2) intractable pain not relieved by conservative management; (3) history of disturbance of urinary or bowel habits; (4) hyperactive reflexes; (5) spasticity.

Four figures; 1 chart.

D. D. ROSENFELD, M.D.
Fontana, Calif.

Vertebral Osteoarthropathy or Charcot's Disease of the Spine. Review of the Literature and a Report of Two Cases. David F. Thomas. J. Bone & Joint Surg. **34-B**: 248–253, May 1952.

The author reports two cases of Charcot's disease of the spine, one in a 49-year-old male and the second in a 46-year-old female. Both patients had low backache. The movements of the spine were free and painless. One patient had a history of syphilis with uncompleted treatment. Radiographic examination revealed involvement of the third, fourth and fifth lumbar vertebrae in one case and of the second and third lumbar vertebrae in the other. The appearances were typical, showing gross disorganization and destruction together with varying degrees of new bone formation, as well as some lateral subluxation of vertebral bodies. There was narrowing of the disk spaces in the involved areas.

Vertebral osteoarthropathy is most commonly discovered in the fifth and sixth decades and is seen more often in men than in women. The lumbar region is most frequently involved.

Eight roentgenograms; 2 photographs.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Peritendinitis Calcarea. Earl P. Holt and Richard T. Odell. South. M. J. **45**: 400–406, May 1952.

The authors contend that peritendinitis calcarea has been inadequately emphasized as a true clinical and pathological entity. It should be separated from a host of pathological calcifications and ossifications in soft tissues near the joints and at a distance. Aside from the common subdeltoid area, calcareous deposits have been reported in areas which are similar anatomically, biochemically, and histologically, including the long head of the triceps, the region of the coracoid process, about the elbow, in the flexor carpi ulnaris, in the capsule of metacarpophalangeal joints, the capsule above the head of the fibula, the quadriceps tendon above the patella, in the knee joint capsule, about the os calcis, the greater trochanter, the biceps, the junction of sacrum and coccyx, and in an interspinous ligament.

Three new sites of calcareous deposition are reported here: the quadratus femoris tendon, the radiocarpal ligament, and the ulnar collateral ligament. Symptoms of pain and tenderness, roentgenographic demonstration of calcific deposits, and exploratory findings of calcium deposits of creamy consistency were present in each case.

In the authors' experience, peritendinous calcium deposits have never been found anywhere except in broad, flat tendons or in ligaments or ligamentous portions of joint capsules. The tendons have subjacent or adjacent bursae or else overlie synovial capsules of joints, which is held to imply a phylogenetic susceptibility of such tissues. The authors contend that evidence that a calcific deposit may turn to bone is extremely scanty and inconclusive. They question the validity of the theories of Leriche and Policard regarding the role of amorphous calcium deposits in heterotopic ossification. References to the literature are made to show that peritendinitis calcarea belongs in the group of dystrophic calcifications, the calcifications of attrition, in which there is evidence that phosphatase plays no role.

Four roentgenograms; 3 photomicrographs; 2 photographs.

W. A. NAFIS, M.D.
Jefferson Medical College

Anteversion of the Neck of the Femur. A Method of Measurement. D. M. Dunn. J. Bone & Joint Surg. **34-B**: 181–186, May 1952.

In congenital dislocations of the hip, some of the poor results after successful reduction in infancy are due to excessive anteversion leading to redislocation. It is therefore desirable to be able to determine the degree of anteversion of the femoral neck, since redislocation can then be avoided by rotation osteotomy. The routine roentgenograms of the femoral neck, however, give a very poor idea of the angle of anteversion. Experimenting with a model made from the femur of a child, the author developed a roentgenographic technic which minimizes the error in determining this angle.

The child lies supine with the hips and knees flexed 90 degrees, the legs being held by an assistant. The film cassette is placed beneath the pelvis, the tube is centered over the upper border of the symphysis pubis, and each leg is abducted 15 degrees from the mid-line, as measured with a protractor. It is important to make sure that the film cassette, the pelvis and the tibiae are parallel to the long axis of the body before the exposure is made. If the tibia is not parallel to the side of the cassette the femur, and with it the femoral neck, is rotated, and there will be no base line from which to measure the anteversion on the roentgenograms.

On the dried film the mid-line of the femoral neck is marked and the angle this makes with the lower edge of the film is measured. This is the uncorrected angle of anteversion of the femoral neck. With this method, the apparent angle as measured is slightly less than the true angle; as the true angle increases, the error increases. A conversion table supplies the necessary additions to the measured angles so that the true angles may be obtained.

The roentgenographic technic is illustrated and clinical roentgenograms as well as the experimental results are shown.

Forty-one roentgenograms; 4 photographs.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Roentgenologic Considerations in Fractures of the Neck of the Femur. A Review of Pertinent Aspects of Diagnosis and Treatment. Nathan P. Salner and Eugene P. Pendergrass. Am. J. Roentgenol. **67**: 732–756, May 1952.

This paper concerns itself primarily with the part that roentgenology plays in the proper evaluation and treatment of fractures of the femoral neck.

The normal anatomy and physiology are described rather fully. "... there are three important anatomical factors which render fractures of the femoral neck less apt to heal than one ordinarily observes in fractures of other long bones. These are (1) the absence, in adults, of external osteogenic function in the femoral neck, resulting in lack of external callus formation; (2) the angulation between the femoral neck and shaft, which arrangement necessarily subjects vertical femoral neck fractures to constant shearing forces, and (3) the variable blood supply to the proximal fragment and the inadequate collateral circulation."

The causes for non-union and aseptic necrosis are discussed. The latter is due to lack of sufficient blood supply to the head fragment. Non-union is caused by aseptic necrosis of the head, faulty reduction with lack of apposition, erosion and absorption of neck fragments, poor blood supply at the fracture site, and interposition of soft parts. Osteoarthritis of the hip joint often follows when the vascular supply to the articular cartilage has been disturbed. About 15 per cent of patients with femoral neck fractures show degenerative changes of the femoral head.

The fractures are classified as adduction and abduction types. The former is the more common; in it the distal fragment and femoral shaft are adducted with respect to the femoral head. The line of weight-bearing is parallel to the fracture site, resulting in a shearing force. In the abduction type the displacement results in valgus deformity, and weight-bearing and muscle pull produce impaction.

The roentgenographic criteria for the proper reduction of fractures of the femoral neck include complete apposition and proper alignment between the proximal and distal fragments, internal rotation of the distal neck fragment to give the neck its full length, some degree of abduction to correct the damage resulting from shearing forces, and positioning of the distal fragment well under and inside the head fragment. The history and methods of fixation are discussed. Proper fixation requires, in addition to satisfactory reduction, that the fixation material be centered in both planes and at proper depth, that there be no angulation or twisting of the head, and that the fixation device enter the femoral shaft at or below the level of the lesser trochanter.

Some of the important complications of internal fixation with the Smith-Petersen nail are discussed. These include intrusion and extrusion of the nail and aseptic necrosis of the femoral head. The authors note that, if the latter is going to occur, it can usually be demonstrated in about six weeks and is fairly marked at the end of three months.

The role of the radiologist in the management of femoral neck fractures can be an important one. At the time of fracture the patient should have an anteroposterior roentgenogram of the hips and pelvis, with feet symmetrical, and a lateral view of the involved hip. Shenton's lines are compared to note the degree of shortening and angulation between the fragments; the degree of rotation of the femoral neck and the presence or absence of acetabular penetration are sought for, as is external rotation of the shaft fragment. In the lateral view one frequently notes anterior angulation at the fracture site. The possibility of a pathologic fracture must be considered and the bony structures should be examined with this in mind. In the interpretation the radiologist should report the location of the fracture line (base of neck, transcervical, or subcapital) and whether it is of abduction or adduction type.

The part of the radiologist in reduction and fixation is described in detail. At the Hospital of the University of Pennsylvania this procedure is done under fluoroscopic guidance, with a multiplane roentgenoscope. For internal fixation without open reduction, the most important step is the proper placement of the guide wire within the head and neck. The position is verified by roentgenograms taken in two positions.

In follow-up examinations one should report any shortening and the degree of varus or valgus deformity. The position and alignment of the fragments and the type of internal fixation and its position should likewise be noted. After the patient is out of the hospital, films should be repeated every three months for the first year and twice yearly thereafter. In addition to the above, one should note the absence or presence of union, the presence of bone absorption at the fracture site

around the fixation device, and the occurrence of arthritic involvement. In the late follow-up period, extrusion or intrusion of the fixing nail may occur, as may aseptic necrosis of the femoral head.

The authors caution that clinical evidence of union is more reliable than the radiological and that "it is not the province of the radiologist to state when union has occurred and when weight-bearing should be allowed."

Thirty-four roentgenograms; 4 photographs; 9 diagrams.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Sciatica Caused by Tumoral Calcinosis. A Case Report. Paul A. Riemenschneider and Arthur Ecker. J. Neurosurg. **9**: 304–307, May 1952.

Tumoral calcinosis occurs in young persons of both sexes. There is probably a familial tendency. The tumors are large, rapidly growing to a definite, self-limited size; they usually occur in or near bursa sites, near large joints, and in connective tissue, immediately overlying bone and muscle attachments. There is usually no pain, tenderness, or limitation of joint motion.

There is a definite multilocular cystic arrangement of the tumor, which has thick, rubbery walls, showing inflammatory foreign-body giant-cell reaction. Deep cystic areas are filled with calcareous material and some milky fluid. On roentgen examination the lesions are seen to consist of single or multiple cyst-like areas of calcification in the regions of bursae and muscles. Many of the individual lesions cannot be differentiated from calcific bursitis.

A case of tumoral calcinosis causing low back and left sciatic pain, with a clinical syndrome suggestive of a protruded intervertebral disk, is presented. The symptoms were apparently the result of pressure by extruded contents of the cystic mass on the first and second sacral nerves within the spinal canal. The symptoms were promptly relieved by operation.

Four roentgenograms.

HOWARD L. STEINBACH, M.D.
University of California

Fractures of the Ankle. IV. Clinical Use of Genetic Roentgen Diagnosis and Genetic Reduction. N. Lauge-Hansen. Arch. Surg. **64**: 488–500, April 1952.

On the basis of roentgenograms, some 228 ankle fractures in adults were diagnosed and classified into four types according to manner of production. The classification conforms with typical roentgenographic findings obtained experimentally in constant and characteristic stages.

The types are described by dual designation of the two main factors producing each, *viz.*, position of the foot in the moment of fracturing and the forced movement producing the fracture. They are characterized by the localization and form of the fibular fracture. Substages under the four types are determined according to combination with one or more other fractures in the ankle. With the exception of fractures caused by direct trauma, all were classified under these four types:

1. Supination-adduction fractures.
2. Supination-eversion fractures.
3. Pronation-abduction fractures.
4. Pronation-eversion fractures.

The author discusses reduction of the four types according to the genesis of the fractures. The material is well presented, with excellent illustrations.

Sixteen roentgenograms; 4 diagrams.

ALLIE WOOLFOLK, M.D.
Pittsburgh, Penna.

Dystrophy of the Fifth Finger. Report of Four Cases. J. N. Wilson. J. Bone & Joint Surg. **34-B**: 236–239, May 1952.

The author reports four cases of a rare deformity of the fifth finger which on superficial examination resembles the clubbing seen in all fingers in chronic lung disease. It is accompanied, however, by a characteristic radial deviation of the terminal phalanx. Six cases have been previously described.

The cause of the condition is unknown; congenital malformation has been suggested. The age of onset is usually eight to twelve years. The age incidence and the radiographic appearance suggest that the lesion is primarily due to osteochondritis. Roentgenograms show radial deviation of the terminal phalanx and in some cases bone sclerosis. The radial deviation is probably due to the long flexor being more powerful than the extensor.

The author's four patients ranged from five to eighteen years of age. All had bilateral deformity. Roentgenograms, available in two cases, show the characteristic deformity.

Two roentgenograms; 3 photographs.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

THE SPINAL CORD

Multiple Spinal Cord Meningiomas. Robert W. Rand. J. Neurosurg. **9**: 310–313, May 1952.

The incidence of multiple meningiomas is small when compared with the frequency of their single occurrence. In most instances of multiplicity the tumors are intracranial or intracranial and spinal. Examples of multiple meningiomas confined exclusively to the spinal cord are rare. The author presents a case of two separate meningiomas of the spinal cord in the sixth and third thoracic segmental levels, unassociated with Recklinghausen's disease. The patient was a 34-year-old white woman who complained of progressive loss of sensation and weakness of the lower extremities. Roentgenograms of the spinal column appeared normal. A myelogram demonstrated a block at the mid portion of the fifth thoracic vertebra with sharp projections of the Pantopaque anteriorly and posteriorly visible in the lateral view. The meningiomas were removed surgically and the patient recovered.

One roentgenogram; 1 drawing; 2 photomicrographs.

HOWARD L. STEINBACH, M.D.
University of California

GYNECOLOGY AND OBSTETRICS

The Uterine Cervix and Isthmus Under Normal and Pathological Conditions. A Clinical and Roentgenological Study. Jan Asplund. Acta radiol., Suppl. 91, 1952.

The author analyzed 1,000 hysterograms with particular reference to the cervix and isthmus under normal conditions, under pathologic conditions, and during pregnancy. An attempt was made in each case to correlate the roentgen findings and clinical history. The

most satisfactory opaque medium was Umbradil Viskös H, and Kjellberg's modification of Schultze's instrument was employed. Anteroposterior, right and left oblique and lateral projections were obtained.

The "normal" cervix radiographically is spindle-shaped and flattened anteroposteriorly. The cervix is usually wider during the proliferative phase of the menstrual cycle. In the multiparous cervix the mucosal pattern is often smoother than in the nullipara.

In about one-half of the material studied the isthmus was distinctly outlined. This varied in width, being much wider in the proliferative phase of the menstrual cycle, due to changes in tone occurring between the thirteenth and sixteenth day of the cycle, at which time ovulation is said to occur.

It was noted that the internal os became narrower following the administration of progesterone and wider following estrogen administration. This finding would support the effectiveness of the use of progesterone to aid in retaining the products of conception by narrowing the internal os.

There was no significant difference between the roentgenographic appearance of the cervix and isthmus of the pregnant uterus except for a general increase in length. In some cases the isthmus was constricted, suggesting that this may represent the "obstetrical" internal os.

The authors observed that the folds of the cervical mucosa ran longitudinally toward the isthmus in 60 per cent of patients with a history of gonorrhea and in 20 per cent with tuberculous salpingitis or endometritis. A wide internal os was found in cases of cystic glandular hyperplasia, submucous myomata, polyps, and habitual abortion. Large fistulas in the region of the isthmus were rarely observed and were usually associated with a tuberculous infection.

Eighty-three illustrations, including excellent reproductions of 66 hysterograms; 11 tables.

ROBERT H. LEAMING, M.D.
Memorial Center, N. Y.

Growth of Biparietal Diameter of Foetal Head in the Last Weeks of Pregnancy. I. Macdonald. Brit. M. J. **1**: 798–800, April 12, 1952.

Those who favor the early induction of labor for the prevention of cephalopelvic disproportion base their practice on the beliefs that during the last weeks of pregnancy the fetal head becomes harder and larger. The second of these two beliefs has been questioned by Josephs (Brit. M. J. **2**: 1440, 1949; Abst. in Radiology **55**: 789, 1950), who could not detect radiologically any increase in the biparietal diameter during the last four weeks of gestation.

The author used steel calipers fitted with a spring platform, so that measurements could be made under standard conditions of pressure, to determine the biparietal diameter of infants' heads forty-eight to ninety-six hours after birth. The individual biparietal diameters of 1,059 infants delivered as a result of the spontaneous onset of labor were plotted against the duration of pregnancy as established from the first day of the last menstrual period of the mother. A statistical calculation was then made to delimit the area within which two-thirds of all the points fell, and it is seen that in general the greater the duration of pregnancy, the greater the biparietal diameter of the head. A further series of measurements of 24 infants delivered after induced labor during the thirty-fifth to thirty-eighth week of pregnancy was made. The mean of these 24 measurements is slightly less than that for babies of comparable age born spontaneously.

The conclusion is that there is growth of the fetal head during the last four weeks of pregnancy, and an explanation is offered for the failure to detect by radiological means increase in the biparietal diameter during the descent of the head. The radiological method of measurement of the biparietal diameter assumes that the largest plane at right angles to the longest diameter of the skull is a perfect circle. This assumption is demonstrably false. The descent of the fetal head with the concomitant backward shift into the pelvic cavity must be of significance. Because the plane of the measurement is not a circle, a systematic change in the position of the axis of the fetal head in relation to the pelvis, and therefore to the source of x-rays, could produce a systematic difference between the measured and the true biparietal diameter.

Three diagrams; 2 graphs.

BERT H. MALONE, M.D.
Brunswick, Ga.

A Table for Gynecography. Irving E. Stein and Robert A. Arens. Am. J. Obst. & Gynec. **63**: 1169–1171, May 1952.

The authors describe a multipurpose table suitable for gynecography, urography, and other types of radiographic examination. This is essentially the Sisk urological table with minor modifications, the most important of which is the addition of an adjustable leaf on one end to allow for proper positioning for pneumoroentgenography and complete gynecography.

Two photographs.

JOHN M. KOHL, M.D.
Jefferson Medical College

THE GENITOURINARY SYSTEM

Diagnosis of Kidney Tumors and Cysts. Robert E. Cone. Texas State J. Med. **48**: 223–230, April 1952.

Early recognition of malignant tumors of the kidneys is imperative if the results of treatment are to be improved. There have been no outstanding developments in the methods for demonstrating kidney tumors within recent years. The radiologist, however, must be alert to the possibility of a renal tumor and be ready to use plain films, oblique and lateral views, excretory urograms, retrograde pyelograms, or a combination of these technics, repeating the examination if necessary, in an effort to identify lesions in the renal area. Physicians should recognize the importance of hematuria and be willing to explore surgically kidneys in which a cancer is suspected.

Some of the procedures of diagnostic value in tumors of the parenchyma and of the renal pelvis and also in cystic disease are mentioned, and 25 illustrative cases are reported briefly.

Twenty-nine roentgenograms.

Atrophic Pyelonephritis Versus Congenital Renal Hypoplasia. John L. Emmett, J. Jose Alvarez-Ierena, and John R. McDonald. J.A.M.A. **148**: 1470–1477, April 26, 1952.

Unilateral hypoplastic or atrophic kidney represents several distinct pathologic entities. The lesion may be congenital or acquired or it may be due to a combination of congenital and acquired factors. There is no

good radiologic evidence to distinguish between a purely acquired hypoplastic kidney and, on the other hand, a kidney which was congenitally small with superimposed "atrophic" changes from chronic pyelonephritis. Other acquired conditions which contribute to the appearance of the small kidney are infarcts, renal lithiasis, and vascular occlusion.

Some 400 cases were reviewed in which urograms showed a definite reduction in size of the kidney. From these, all but 183 cases were eliminated because the etiologic agent for "atrophy" was readily apparent (calculi, cyst, pyelectasis, etc.). In 79 of the 183 cases, nephrectomy had been performed and the specimen was available for gross and microscopic study. The material was analyzed in terms of anamnestic, laboratory, and all other available data.

Gross and microscopic features of the kidneys were studied to determine whether there were any criteria to permit segregation of specimens into separate groups or classifications. As a result of this analysis, grouping or classification was proved to be impractical if not wholly impossible. The importance of hypertension as a cause of small kidney or *vice versa* is not challenged by this study; the observations show that the relationship is not invariable (as was known before) but, further, that satisfactory criteria for recognition of the small kidney which is associated with hypertension have not been developed clinically, pyelographically, or pathologically.

The entire discussion is concerned with the unilateral small kidney. When the cause of the "atrophy" is not apparent, the wisest course is to employ a non-etiologic descriptive term.

Sixteen roentgenograms; 2 photomicrographs; 6 tables.

DONALD DEF. BAUER, M.D.
Coos Bay, Ore.

The Effect of Psoas Abscesses upon the Kidneys and Urinary Passages (Hydronephrosis). N. Lauge-Hansen. Am. J. Roentgenol. **67**: 788–795, May 1952.

The author reports 10 cases of psoas abscess, unilateral or bilateral, with varying degrees of hydronephrosis. Seven patients suffered from spondylitis (3 tuberculous); 1 had left sacroiliac osteitis, 1 a shell fragment fracture of the left femur, and 1 a retroperitoneal malignant tumor. The hydronephrosis is apparently secondary to ureteral compression or displacement, with varying degrees of obstruction.

In the author's cases there were frequently diagnostic difficulties, which were cleared up only by intravenous urography. He states that "intravenous urography should presumably be done immediately after the onset of the disease in all patients with destructive processes of the spinal column and the pelvis and with inflammations of the extremities where there are abdominal symptoms, and should be repeated as long as the patient is under medical attention."

Ten roentgenograms.

BERTRAM LEVIN, M.D.
Minneapolis, Minn.

The Problem of Calyceal Diverticulum. Harry R. Newman, Robert M. Lowman, and Levin L. Waters. Surg., Gynec. & Obst. **94**: 77–82, January 1952.

The term "calyceal diverticulum" is not a new one, but most authors are at variance concerning its exact meaning. As a result, this entity is often designated as "pyelogenic cyst" or "hydrocalycosis." In this paper the term "calyceal diverticulum" is utilized to describe "a cavity containing urine arising peripherally or distal to the calyx to which it is connected by a narrowed isthmus." The calyx itself usually shows little or no evidence of obstructive uropathy. The diverticulum is lined with transitional epithelium which is continuous with that of the calyx. Calyceal diverticulum must be distinguished from a solitary cyst of the kidney, which shows no communication with the calyx or renal pelvis and which is lined with flattened cuboidal epithelium.

Some authors contend that calyceal diverticula are of congenital origin. Others believe that a previous infection or abnormal function of the musculature is responsible.

No specific clinical picture is produced. The condition has been seen predominantly in males, who are quite often symptom-free. Some complain of pain in the flank. The physical examination is usually negative, and renal function is good unless there is associated renal disease. Calculi may be found in the diverticulum as a result of stasis of urine.

Diagnostic methods include intravenous urography and retrograde pyelography. Films must be made in several positions to localize the diverticular dilatation. Well defined, opaque, rounded areas are demonstrated adjacent and distal to the calyces, filled with contrast medium. Retention of the medium in the diverticulum after removal of the catheter is a characteristic finding.

The authors present a group of 6 cases of calyceal diverticulum and summarize the roentgen and surgical findings in 4 of the patients. In 2 there were associated changes in the kidney, due to chronic pyelonephritis.

The management of a calyceal diverticulum depends on its size, its location, and whether or not there are associated pathological changes. If surgery is necessary, the goal should be complete eradication of the diverticular cavity or enlargement of the channel draining it. The authors describe several specific surgical procedures to accomplish these ends.

Five roentgenograms; 2 photomicrographs.

LOIS I. KING, M.D.
University of Pennsylvania

Intrarenal Lipoma: Report of a Case. Robert O. Beadles, Jr., and R. W. Urich. J. Urol. **67**: 460–463, April 1952.

A case of an intrarenal lipoma occurring in a 52-year-old white female is presented.

The patient and her husband were stricken suddenly with fever, nausea, vomiting, and diarrhea. Two days later her husband had recovered but she continued to have fever (100 F.), nausea, and vomiting. At the onset of her illness she noticed a tender mass in the right upper quadrant of the abdomen. Ten days after the onset, all symptoms and signs except this "lump" had disappeared. On examination, it was the only positive finding. The mass measured roughly 6 × 8 cm., was superficial, and when manipulated caused pain referred to the right flank. Cholecystographic study and barium enema examination showed it to be separated from the gallbladder and bowel, although the hepatic flexure was depressed.

Retrograde pyelography revealed a normal bladder and ureters with apparently normal renal function bilaterally. However, the superior major calyx on the right was depressed. For this reason, surgery was undertaken.

At operation, a large tumor of the right kidney was found and nephrectomy was performed. The kidney with its tumor weighed 520 gm. and measured 13.5 × 8.5 × 6.5 cm. A large mass, 8.5 cm. in diameter, involved the posterior half of the upper pole; in its periphery it bulged into the perinephric fat and centrally it infiltrated the renal parenchyma, pushing between the tubules and the glomeruli. There was also hemorrhage into the tumor. The pathologic diagnosis was intrarenal lipoma.

Intrarenal lipomata are the rarest of all renal tumors. To date, 16 have been reported in the literature. Since the kidneys do not normally contain fat, the origin of these tumors is in doubt. Alsbert believed they arose from embryonic fatty rests; others feel they begin from intertubular and perivascular connective tissue which has undergone fatty change. Common symptoms are pain at the site of the lesion and vague digestive complaints. Pyelography presents the changes common to other renal tumors. Two cases previously reported had normal pyelograms bilaterally, and in one case a stone was seen.

Six roentgenograms; 2 photographs; 1 photomicrograph.

THOMAS R. HELPER, M.D.
University of Pennsylvania

Ureterocele: A Study of 94 Instances in 80 Infants and Children. Meredith Campbell. Surg., Gynec. & Obst. **93**: 705–718, December 1951.

A detailed study has been made of 80 cases of congenital ureterocele in infants and children. The diagnosis was made both by cystoscopic and by radiographic examination. Radiographically the lesion may be positively demonstrated by urographic filling or may be negatively demonstrated as a globular filling defect in the bladder.

The author found ureterocele in 3.5 per cent of his series of children examined for persistent pyuria. Associated congenital anomalies were common. The lesions were classified as "large" in 28 cases, "small" in 30; in 13 patients they were bilateral. Marked hydroureter of the segment drained by the ureterocele was present in 41 cases and severe hydronephrosis in 34. Secondary infection was the usual and most important complication. Gross pyuria was present in 51 cases.

Descriptions of treatment and final results are included.

Eight roentgenograms; 11 drawings; 4 tables.

ADELE KYNETTE, M.D.
University of Pennsylvania

Herniation of the Ureter into the Sciatic Foramen ("Curlicue Ureter"). William C. Beck, William Baurys, Jean Brochu, and William A. Morton. J.A.M.A. **149**: 441–442, May 31, 1952.

Herniation of a ureter into the sciatic foramen is extremely rare. The first case recorded was that of Lindbom (Acta radiol. **28**: 225, 1947). The authors report a second case in a 66-year-old woman who had a left mid-thigh amputation for gangrene, a malunited fracture of the left hip, and atrophy of the gluteal musculature; it is impossible to evaluate the part these conditions played in producing the herniation. The roentgenographic appearance of the ureteral deformity is typical and diagnostic, and the authors call it "curlicue ureter." The "curlicue" appearance was also seen in Lindbom's case.

Two roentgenograms.

THE SPLEEN

Ruptured Spleen: Diagnosis by Serial X-Ray Examinations. George Thomas, Harry A. Reinhart, and J. Gershon-Cohen. J.A.M.A. **149**: 143–144, May 10, 1952.

A case of ruptured spleen is reported in which serial x-ray examinations, as described in RADIOLOGY (**57**: 521, 1951) revealed an enlarging splenic shadow, increasing displacement of the splenic flexure of the colon, and separation of the intestinal loops by free blood in the peritoneum. The value of these findings in the diagnosis of ruptured spleen is emphasized.

Two roentgenograms.

BLOOD VESSELS

Post-Mortem Diagnosis of Air Embolism by Radiography. J. Duncan Taylor. Brit. M. J. **1**: 890–893, April 26, 1952.

The postmortem diagnosis of air embolism depends upon the demonstration of bubbles of air within the blood vessels and within one or more of the heart cavities. Experimentally, however, it has been demonstrated that some spore-bearing, gas-producing organisms may invade the tissues of rabbits and guinea-pigs shortly after death. This possibility must therefore be excluded by anaerobic bacteriological examination before a diagnosis of air embolism is made. Another source of gas bubbles which must be taken into account is manipulation of the viscera during necropsy. Radiologic examination prior to necropsy has been suggested to overcome this difficulty. Two cases are here reported in which such an examination was made within an hour after death: a case of arterial air embolism and one of pulmonary air embolism.

The mechanism of death in the two types of air embolism is discussed, with special reference to the circulatory pathways involved.

Four roentgenograms.

MARIO TAMBURINI, M.D.
Pittsburgh, Penna.

Budd-Chiari's Syndrome. High Inferior Vena Caval Obstruction Demonstrated by Venography. B. Bronte-Stewart and R. H. Goetz. Angiology **3**: 167–178, April 1952.

The Budd-Chiari syndrome arises from interference with the venous return from the liver, but little is known about its cause. The obstruction may be in the hepatic veins themselves, their ostia or, as in the majority of cases, in the inferior vena cava. The opportunity to diagnose the syndrome does not often present itself to the clinician, and until recently such a diagnosis without laparotomy or a postmortem examination could be only presumptive. The development of angiography, however, has supplied a means for confirmation of the diagnosis in most instances. This is of great importance, as operative intervention may hasten the terminal thrombosis.

The authors report a case presenting all the features of a Budd-Chiari syndrome. Venography demonstrated an occlusion of the upper part of the inferior vena cava and outlined the degree of collateral circulation. Features aiding in the clinical diagnosis, which have not been stressed by other authors, included: (1) bilateral varicocele; (2) discrepancy of body build, the patient being well developed below the xiphisternum and very thin about the chest, neck, and arms; (3) the

presence of abdominal collateral veins with the blood flowing from the pubis upward, but not containing blood from the splanchnic viscera. The glucose tolerance curve suggested that none of the abdominal veins contained portal blood.

A hard, firm hepatomegaly and splenomegaly with normal liver function tests and only a slight increase in portal connective tissue histologically completed the syndrome of chronic hepatic vein obstruction.

Eight roentgenograms; 4 photographs and photomicrographs; 2 drawings.

TECHNIC: CONTRAST MEDIA

Roentgenologic Control of Nerve Blocks. Use of Iodopyracet Injection (Diodrast). F. A. Duncan Alexander and B. K. Lovell. J.A.M.A. **148:** 885–886, March 15, 1952.

The authors have utilized 35 per cent Diodrast to demonstrate roentgenographically the distribution of anesthetic agents injected for interruption of pain pathways. Diodrast was chosen as the contrast medium because of its similarity in physical properties to the anesthetic solutions used for therapeutic nerve blocks. Preliminary screening tests were at first carried out for sensitivity, but as there was no instance of untoward reaction to the drug, these were discontinued. The procedure was performed in 710 patients.

After the needles have been inserted for injection of the nerve-blocking solution, the accuracy of their position is established roentgenographically. A local anesthetic agent is then introduced, and after ten or fifteen minutes, if pain relief is satisfactory, Diodrast is injected and additional films are made. If there is a satisfactory distribution of the Diodrast, the nerve-blocking procedure is concluded with the injection of the appropriate amount of 6 per cent phenol or absolute alcohol.

Roentgenologic control is most valuable in blocks of the sympathetic ganglionated chain and the splanchnic nerves, in paravertebral thoracic and lumbar somatic blocks, and in suprascapular nerve blocks. It is of no value in cranial nerve blocks and of little use in peripheral blocks.

A letter by Ralph R. Landes (J.A.M.A. **149:** 1053, July 12, 1952) commenting on this paper calls attention to the occasional inadvertent extravasation of Diodrast into the perirenal and periureteral spaces in the course of pyelography and the possible danger of this mischance. He concludes: "Whether perineural fibrosis takes place and whether this may cause permanent damage should be considered in using the described technique."

Five roentgenograms.

ROBERT H. LEAMING, M.D.
Memorial Center, New York

Changes Caused by Thorotrast Following Bronchography, Retrograde Pyelography, Salpingography, and Arteriography. J. Vögtlin and W. Minder. Radiol. clin. **21:** 96–115, March 1952. (In German)

Four cases of damage due to the use of thorotrast for bronchography, retrograde pyelography, salpingography, and cerebral arteriography, respectively, are described. In the first case granulomas in association with a primary squamous-cell carcinoma of the lungs were found eighteen years after bronchography with thorotrast. This is the first case of thorotrast granuloma in the lungs proved microscopically, and the histologic picture is discussed in detail, the productive and regressive tissue changes being compared with those in thorotrast granulomas found in other organs and tissues. The granulomas were radioactive. The possibility of thorotrast as a cause of the carcinoma is discussed at length, especially as the carcinogenic action of thorotrast has been clearly established in animals.

In the second case extensive deposits of thorotrast were observed in the renal capsule and perirenal tissue three years after retrograde pyelography. Inflammatory changes within the renal pelvis and parenchyma were in all probability attributable to a pre-existing hydronephrosis, as no radioactive material could be found there. The histologic picture of thorotrast deposition was similar to that of thorotrast granulomas in the lungs and elsewhere.

In the third case thorotrast granulomas were found in the serosa of the true pelvis, in the appendiceal area, and within the tubes, three years after salpingography. The possibility of radiation damage to the ovaries by thorotrast is discussed, and for this reason its use in salpingography is contraindicated.

The fourth case showed thorotrast deposits in the liver, spleen, and a mediastinal lymph node five years after cerebral arteriography. This case is an example of hematogenous and lymphogenous transportation of the medium, particularly to the reticulo-endothelial system, where, in addition to thorotrast storage, evidence of necrosis and connective-tissue proliferation was found.

Thirteen illustrations, including 2 roentgenograms.

HERBERT POLLACK, M.D.
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RADIOTHERAPY

Irradiation of Retinoblastoma (Glioma Retinæ). H. B. Stallard. Lancet **1:** 1046–1049, May 24, 1952.

The author compared the results of radium and x-ray therapy in 4 series of patients with retinoblastoma: (1) 29 unselected cases, 16 treated with 2 mc. radon seeds in 1934–38 and 13 (14 eyes) with curved radium disks in 1948–51; (2) 5 patients treated with radon seeds in 1929–37 by Foster Moore, a pioneer in this type of therapy; (3) 17 patients treated by other surgeons; (4) 8 patients treated with radium needles at the Christie Hospital and Holt Radium Institute, Manchester, in 1935–49. He believes that the prospect of successful irradiation is good when the retinoblastoma affects a third or less of the retina and has not invaded the optic disk. It is, however, most unlikely that even "guiding vision" will be saved when more than half the retina has been destroyed by the neoplasm. In such advanced cases, even when the retinoblastoma is completely destroyed, complications such as complete retinal detachment, severe intra-ocular hemorrhage, iridocyclitis, and endophthalmitis render the eye blind.

The dose of irradiation is still empirical. In the author's opinion, a dose of 2,500–3,000 r at the summit of the neoplasm and up to 6,000–8,000 r at its base is generally effective. He feels that it is desirable "to bring the therapeutic artillery as close as possible to the

target and to hit it hard and quickly with a concentration of fire that is known to be both effective and reasonably safe for the eye." To achieve this, he thinks that radium disks made to fit the scleral curvature evenly are better than radon seeds and other applicators used hitherto. This technic is preferable to long-range shooting with heavy doses from radium needles fixed in Columbia paste plaques or from the radium bomb, for both of these methods are disastrous for the eye and quite often fail to destroy the neoplasm completely.

Although deep x-ray therapy is successful in some cases, where less than a third of the retina is involved, it has the technical disadvantage of protracted treatment—the difficulty of maintaining the necessary immobility of a child's head—and it produces a higher incidence of serious complications than is seen after the application of a radium disk or a radon seed. In several series in which the size of the retinoblastoma was fairly comparable, the results of treatment with radon seeds and radium disks were appreciably better than the results of treatment with deep x-rays, radium plaques applied externally, or radium needles inserted into the orbital tissues around the eye.

Four illustrations.

Diagnosis and Treatment of Cancer of the Larynx. Use of Median Thyrotomy, Laryngectomy, Irradiation, and Irradiation with Surgery. Gabriel Tucker. J.A.M.A. **149**: 119–121, May 10, 1952.

The first consideration in the cure of cancer of the larynx is early diagnosis. The publicizing of hoarseness as a danger signal of cancer has been effective in warning the public and has resulted in early diagnosis in many instances. Emphasis on local discomfort as an early symptom should be similarly rewarding.

Surgery is the treatment of choice in selected cases of laryngeal cancer. Irradiation has proved most valuable in cancer in the older age group and in those patients whose general condition contraindicates operative intervention.

It is fortunate that at least 70 per cent of the lesions of the larynx originate in the vocal area. Cancer in this area is within the thyroid cartilage and is well guarded from metastatic extension. Median thyrotomy (laryngofissure) results in a high percentage of cure in these cases.

When the patient requires total laryngectomy because of the extent of the lesion, the important protective function of the larynx is lost, and the voice is gone. The purpose of surgical intervention, however, is to prevent recurrence, and the less extensive excision of thyrotomy should not be used in an effort to save the voice when there is need for total laryngectomy. In cases in which there is evidence of metastatic nodes and extensive cancer, block dissection of the affected side may be done either at the time of the laryngectomy or at a later date, as indicated in the individual case. Laryngectomy may also be required if the growth recurs in the larynx after the patient has been treated by thyrotomy.

Of 152 patients treated by median thyrotomy, 86 per cent were free from recurrence for five years or longer. Of 102 patients treated by laryngectomy, 61 per cent were free from recurrence for five years or longer.

Results obtained with irradiation are known only approximately. It is felt that the best results were obtained in patients over sixty-five years of age. In general, it is believed that in this group irradiation has produced worth-while palliation and five-year cures in at least 25 per cent. In the middle-aged group, vocal area cancer recurred after irradiation in a high percentage of patients. In such cases cures have been effected by thyrotomy or laryngectomy.

One illustration.

DANIEL WILNER, M.D.
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Roentgen Therapy of Carcinoma of the Larynx. L. H. Garland and M. A. Sisson. Surg., Gynec. & Obst. **94**: 598–604, May 1952.

This paper is based on 132 treated cases of proved carcinoma of the larynx, 69 of which received therapy prior to 1946. Of these 69 cases, only 44 fall into the "determinate" group which was followed for five years. The others were lost to follow-up or died of some other cause than carcinoma of the larynx.

In 1934, a simple classification was set up based on stages of intrinsic or extrinsic lesions:

Intrinsic: Tumors arising from the true cord or laryngeal ventricle.

Stage I: Single cord, without fixation.
Stage II: Both cords, or one with partial fixation.
Stage III: One or both cords, with invasion of cartilage or metastasis.

Extrinsic: Tumors arising fro n the upper surface or false cord, epiglottis, aryepiglottic fold, arytenoid, laryngeal surface of pyriform sinus, or postcricoid area.

Stage I: Less than 1.0 cm. in diameter.
Stage II: From 1 to 3 cm., but without cartilage invasion.
Stage III: Over 3 cm., or with cartilage invasion or metastases.

Technical factors in treatment were as follows: 200 to 250 kv., 15 to 20 ma., half-value layer 1 to 2 mm. Cu, target-skin distance 50 to 70 cm. Portal sizes were as small as possible, ranging between 10 × 8 cm., and 5 × 5 cm. The size of the portal was often decreased during therapy just as the daily dose was increased gradually from 100 to 300 r (air). The tumor dose striven for was 5,000 r; this was increased in the absence of an epithelitis, but treatment was discontinued if severe epithelitis occurred. Mucositis often persisted as long as three months before it completely subsided. Mirror examinations were carried out before, during, and after therapy. Fluoroscopy was used to localize and mark the tumor. For uniformity, the same therapist supervised any given case throughout treatment.

Though no correlation could be established between the microscopic grading and the results of irradiation, the clinical stage of the lesion was of utmost importance. Of the 13 patients who were alive at the end of five years, 7 had disease of Stages I and II. The importance of location is evident from the fact that the cure rate for the intrinsic lesions (Stages I and II) was 80 per cent.

The authors realize that their results are poorer than those of other therapists. They point out that many of their cases were far advanced carcinoma; 18 patients had undergone tracheotomy prior to treatment and 6 had tracheotomy during or after therapy. Chondronecrosis with subsequent edema and bronchopneumonia accounted for two deaths. The survival rate might have been increased in this group if the patients had received a higher tissue dose (average 4,400 to 6,300 r in thirty-five days), but the incidence of chondronecrosis would, undoubtedly, have been higher.

When there is clinical evidence of involvement of one or two lymph nodes immediately adjacent to the larynx, and these can be included in the beam used for the primary lesion, roentgen therapy has sometimes been successful. In cases in which the nodes are numerous, however, or are situated at some distance, the authors have had no cures. For metastatic nodes appearing after control of the original lesion they suggest: (1) for solitary nodes at some distance, excision or irradiation following aspiration biopsy; (2) for multiple nodes, apparently operable, in the area of former irradiation, neck dissection; (3) for multiple fixed nodes, palliative irradiation.

Because of their results, especially in terms of function, the authors are of the opinion that roentgen therapy is the treatment of choice in early carcinoma of the larynx.

Eight tables.

STEPHEN P. SEDLAK, M.D.
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Newer Palliative Measures in the Management of Inoperable Bronchogenic Carcinoma. Edgar Mayer and Bernard Roswit. Dis. of Chest **21**: 491–512, May 1952.

Because the over-all survival rate of bronchogenic carcinoma of the lung is only 5 per cent, and because 90 per cent of their own cases were inoperable and 65 per cent had metastases on admission, the authors stress the importance of palliative measures applicable to this condition. They give their results with radiation therapy, nitrogen mustard, surgical technic, and medical procedures.

During the past fifteen years, in a series of more than 600 patients, radiation therapy has proved the most effective measure for symptomatic relief. In selected cases effective palliation of intractable symptoms such as pain, cough, expectoration, dyspnea, orthopnea, and hemoptysis, was obtained. Associated with this there was objective evidence of improvement, such as disappearance of obstructive pneumonitis, regression of parenchymal infiltration, shrinking of hilar, mediastinal and peripheral lymph nodes, healing of pathological fractures, and relief from the superior vena cava compression syndrome. Significant contributions to roentgen therapy during the past five years include more accurate localization of the tumor through new roentgenographic technics; more precisional cross-fire irradiation through multiple portals with the aid of recent engineering devices; new rotation procedures; a closer approach to an optimum dose formula; reduction of local and systemic reactions; a trend toward extremely high-energy irradiation.

When irradiation cannot be offered, or is found to be unfeasible or ineffective, nitrogen mustard (HN_2) was found to be a valuable systemic adjunct. In a series of 40 cases one of the authors (B.R.) reported favorable subjective responses in 30, with relief from fever, night sweats, weakness, anorexia, chest pain, cough, and dyspnea, lasting from one to seventeen weeks. In 19 of these 30 cases, objective signs of improvement included relief from acute superior vena cava compression syndrome, gain in weight, resorption of pleural fluid, and increased pulmonary aeration. In 12, improvement in systemic symptoms permitted initiation of definitive x-ray therapy.

Under palliative surgery the authors mention resection of the lesion, fulguration *via* the bronchoscope, intercostal nerve block followed, if successful, by neurectomy, phrenic nerve resection, posterior rhizotomy, unilateral and bilateral cordotomy, and unilateral and bilateral prefontal lobotomy.

The palliative medical measures used supplemented radiation, HN_2 and surgery. They included drugs acting on the bronchi and their secretions, postural drainage, steam inhalations, antibiotics, narcotics, ethyl chloride spray, intravenous procaine, and intravenous ethyl alcohol.

In the management of malnutrition and cachexia, high protein and high carbohydrate diets were used, supplemented by amino acids, either orally or intravenously, preprandial brandy or whisky, emulsified fats orally or intravenously, testosterone to influence the nitrogen balance, adrenal cortical extracts, and cortisone.

Case histories and illustrations are included.

[Worth reading.—H. K. T.]

Ten roentgenograms; 2 photographs.

HENRY K. TAYLOR, M.D.
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Diagnosis and Management of Uterine Malignancy. Lewis C. Scheffey. West. J. Surg. **60**: 144–155, April 1952.

In 1948 there were 17,120 deaths in the U.S. from uterine cancer, and 70 per cent of these cases were well advanced when first treated. The Committee for Study of Pelvic Cancer in Philadelphia analyzed 2,418 cases over the period 1945–51 and determined that the delay period between initial symptoms and primary treatment was the fault of the patient in 38.8 per cent, that the physician was responsible for delay in 15.5 per cent, and that there were both physician and patient delay in 15.0 per cent. Institutional delay was found in 1.9 per cent and no delay in 28.8 per cent. Analysis of the cases according to individual organ involvement showed that delay from all sources was greatest in cancer of the vulva (85 per cent). Delay was found less often in cancer of the corpus uteri (61.7 per cent) and in cervical carcinoma (56 per cent). It is obvious that further education of the public is needed. The physician must also become more thorough in his history taking and physical examination. The circular biopsy at the squamocolumnar junction of the cervix is the recommended diagnostic procedure in cervical cases.

Various methods of managing cervical carcinoma from 1921 to 1946, as employed at Jefferson Medical College Hospital (Philadelphia), are reviewed. The five-year survival rate for 222 cases treated primarily with radium and sporadic x-ray irradiation was 27.9 per cent. The second phase of therapy utilized preliminary x-ray irradiation and subsequent radium therapy and yielded 34.6 per cent survival for 107 cases. Since 1942, 65 cases have been treated with x-rays, including a vaginal cone, followed by radium, with 47.6 five-year survivals. In this last group of patients a parametrial dose of 3,500 r is attempted through one anterior and one opposing posterior field over five to six weeks. The dosage from the vaginal cone has recently been increased from 1,600 r (air) to 3,000 r. Surgical procedures in selected cases, either primarily with a true Wertheim procedure or secondarily with extraperitoneal lymphadenectomy after successful irradiation, must be considered more and more, as evidenced by instances of recurrence as late as ten to twelve years in an appreciable number of patients in this series.

Treatment of 46 cases of carcinoma of the corpus uteri

has given 91.3 per cent five-year survival when intrauterine radium amounting to 5,000 mg. hr. is followed by complete hysterectomy and bilateral salpingo-oöphorectomy. No postoperative irradiation is given in these cases without definite evidence of extra-uterine extension.

Thirteen tables.

RICHARD F. MCCLURE, M.D.
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The Elimination of Untoward Radiation Sequelae in the Treatment of Carcinoma of the Uterine Cervix. James F. Nolan and Lucille Du Sault. Surg., Gynec. & Obst. **94**: 539–542, May 1952.

An attempt is made to analyze, from the authors' own experience, the clinical occurrence of factitial radiation reactions in the treatment of carcinoma of the uterine cervix, with particular attention to the importance of their elimination.

It must be assumed that ionizing radiations are traumatic to all tissues and that their therapeutic effect lies in the differential recovery rate between cancer tissue and the surrounding normal tissue. The authors postulate that there is a minimal amount of radiation which will destroy or inactivate the tumor and a maximal amount which will prevent the normal tissue of the tumor bed from recovering from injury. If this premise is true and the incidence of both complications and clinical successes can be found to parallel a quantitative expression of the amount of radiation delivered, then the relationship between complications and results can be examined. In other words, the importance of eliminating untoward reactions should lie in the relationship between complications and outcome.

The study is based on a series of 214 patients with carcinoma of the cervix, clinical Stages I, II, and III, primarily treated at the Los Angeles Tumor Institute, between 1945 and 1950.

The treatment included external roentgen therapy and radium implantation. The factors for roentgen therapy were 500 kv., 5 ma., 1 mm. lead filter, 50 cm. S.T.D., 6 mm. copper half-value layer. Usually two anterior and two posterior pelvic portals of 150 sq. cm. were used, and daily dosage of 150 r (air) to two portals, for a total of 1,800 r (air) to each. For radium application, intrauterine tandems, intravaginal bombs, intravaginal sponge rubber colpostats, interstitial parametrial needles, and the Ernst applicator were employed. Total exposures were in the order of 6,000 mg. hours, with the actual dose expressed at point A in the order of 7,000 gamma roentgens.

The percentage incidence of complications involving the bowel, genito-urinary system, and the uterus and parametria locally is represented graphically. The complications are further divided according to severity, depending upon the degree of disability. Minor complications are, of course, of higher incidence than the moderate or major ones. Of the group, diarrhea and local necrosis or telangiectasia are the most common.

The incidence of complications in relation to dose is then studied. The incidence of bowel, bladder, and genital complications is compared in relation to the total dose at point A. Cervical necrosis or uterine inflammations do not appear dependent upon the amount of radiation delivered to this key point in the pelvis, but seem to be closely related to other factors, such as the type of applicator and the condition of the patient. The incidence of proctitis and cystitis indicated a dependence upon dosage.

Three important factors are closely related to success or failure of treatment: the gross extent of the lesion, the amount of radiation delivered, and the time in which the total dose is delivered. An attempt is made to correlate clinical success or failure with complications by taking into account these three influences. By means of a plotted chart, the authors show that 91 per cent of complications for all stages occur above the "minimal complications line," which extends from 7,000 roentgens at twenty-five days through 9,000 roentgens at seventy-three days.

Another graph shows the occurrence of complicated and uncomplicated cases and clinical successes and failures according to dose-time relationship for the Stage I group. A straight line is drawn, above which the complicated cases appear. Treatment was successful in 92 per cent of the cases below this line as compared to 80 per cent of those above, from which we can assume that an optimal dose for Stage I lesions lies near that which will cause complications. In the Stage II cases, 58 per cent of the cases above the complications line were successfully treated and 52 per cent of those beneath it. In this group, however, the correlation of reactions with parametrial dose is not quite valid, for radium placed against a vaginal metastasis may cause rectal complications and yet contribute little to the parametrial dose. On the other hand, higher dosage to point A alone may not affect the control of downward vaginal extension.

In the Stage III cases, the percentages of success were 43 above the minimal complications line and 33 beneath the line. In this stage the spread of disease is, presumably, beyond point A, and if the outer limits of extension are treated adequately, fairly high doses must be delivered to point A. Therefore, with our present technics complications must be expected in order to achieve clinical cure.

The answer to the question as to whether these complications must be accepted as a necessary sequel to treatment based upon the analyses drawn must be "yes" in the case of advanced lesions and "no" in the case of early ones.

Six graphs.

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Tumors of the Testicle: Irradiation Therapy. J. C. Kimbrough. Surg., Gynec. & Obst. **94**: 535–538, May 1952.

From the point of view of treatment, tumors of the testicle can be classified in two groups: (1) the radiosensitive seminoma and (2) the radioresistant embryonal carcinoma, teratoma, and teratocarcinoma or chorioepithelioma. Seminoma may be the precursor of the other types and may metastasize in their form.

The treatment of choice in all malignant tumors of the testis is early orchiectomy and resection of the lumbar lymphatics, followed by irradiation therapy. This has given better results than simple orchiectomy with irradiation, as the earliest metastases are to the lumbar lymph nodes. Preoperative irradiation is not sound practice, as it delays operation and interferes with the appearance of the pathologic specimen.

At the Walter Reed Hospital the lymphatic drainage channels are irradiated from the inguinal ring to the diaphragm, anteriorly and posteriorly. If the retroperitoneal nodes have been found at operation to be involved, the patient is also irradiated from the diaphragm upward to the left supraclavicular areas. The

total tumor dose is 2,000 tissue roentgens in fifteen days for seminomas and 4,000 tissue roentgens in twenty-five days to the radioresistant types (1,000 kv.). Pyridoxine, 100 mg. intramuscularly, is given before each treatment. Complications of therapy are radiation sickness, fatigue, infertility, diminished libido, and impotence.

RICHARD V. WILSON, M.D.
University of Pennsylvania

Contact X-Ray Therapy of the Common Wart. John G. Thomsen and John E. Rauschkolb. Arch. Dermat. & Syph. **65**: 553–556, May 1952.

Between September 1948 and March 1951, the authors treated 117 patients with one or more warts by contact x-ray therapy. A total of 540 lesions were distributed regionally as follows: hands 358, feet 153, elsewhere 29. The wart was first pared with a scalpel, since it is essential to reduce each lesion to as flat a plane as possible to insure even distribution of radiation. In subungual lesions the nails were carefully trimmed or clipped in order to expose the entire wart. Treatment consisted of a single exposure varying, in the majority of patients, between 2,100 and 2,500 r. A few large lesions were given doses as low as 1,500 r; a few very small lesions received up to 2,750 r. The results of treatment were observed in 489 of the 540 lesions for a minimum period of three weeks. Of 321 lesions on the hand, 276 (86.0 per cent) were cured; of 141 lesions on the feet, 108 (76.6 per cent) were cured; 25 of the 27 lesions elsewhere on the body were cured, but the series is too small to be of statistical significance. It is believed that a higher percentage of cures might have been obtained with slightly higher doses of radiation.

In the opinion of the authors, contact x-ray therapy has certain advantages over conventional x-ray technics and over other forms of treatment. The necessity of extreme attention to detail for the safety of the patient and operating personnel is emphasized.

Intra-uterine Radium Treatment for Benign Uterine Hemorrhages. W. Neuweiler and H. Aeppli. Radiol. clin. **21**: 89–96, March 1952. (In German)

Uterine hemorrhage of the preclimacterium and climacterium are among the most frequent complaints encountered in gynecologic practice. Curettage should be done in all cases to obtain an exact diagnosis of the underlying disease and is of therapeutic value in a number of benign conditions. Cancer, of course, must be treated accordingly.

In recurrence of hemorrhage after curettage, repetition of the procedure or some other form of treatment is required. In women close to the menopause, x-ray castration is the method of choice, but in younger women, treatment with male hormones or intra-uterine radium insertion is to be preferred. The purpose of the latter is to act locally on the uterine mucosa, producing an atrophy of the endometrium and avoiding a strong irradiation effect on the ovaries. The average dosage used by the authors was 1,400 to 2,000 mg. hours; in only 2 cases was 4,000 mg. hours required.

In order to increase the local action on the endometrium and decrease the radium effect on the ovaries, a very soft radiation was employed with low-penetrating power, by using a radium source containing mainly beta rays. Czech, who used this method in the Clinic at Göttingen, recently reported promising results. Despite all these precautions, however, the ovaries receive an average dose of 500 to 700 r, which occasionally leads to menopausal symptoms. In such cases hormone therapy can be safely used, as the extensive damage of the endometrium prevents the formation of a normal functioning uterine mucosa. Consequently recurrent bleeding can be avoided.

Since 1931, 62 patients had received intra-uterine radium therapy for benign uterine hemorrhage, but only 35 could be followed. In 18 of these, amenorrhea occurred instantly. It ensued after one to three menstrual periods in 6 cases. Seven patients had to undergo further treatment, and in 4 the menstrual cycle became normal, which, of course, is the ideal result. In these 4 cases, the endometrium apparently underwent a selective atrophy and the ovaries were not damaged to any noticeable extent.

Climacteric symptoms of such intensity that they needed treatment were present in 6 cases. Complications were not observed.

Three charts.

HERBERT POLLACK, M.D.
Chicago, Ill.

Radiotherapy in the Treatment of Nonspecific Inflammatory Stricture of the Ureter. Gordon D. Oppenheimer, Lester Narins, and Norman Simon. J. Urol. **67**: 476–478, April 1952.

The use of radiotherapy in superficial and deep infections has become less frequent since the efficacy of chemotherapeutic and antibiotic agents has been established. The authors present a case of non-specific inflammatory obstruction of the ureter which was treated with x-rays with beneficial effect, after treatment with surgery and antibiotics had been unsuccessful.

A 57-year-old white man gave a history of right pubic pain for two years and intermittent gross painless hematuria for three months. There were no other complaints and the past history and system review were not contributory. The only significant findings on physical examination were a blood pressure of 170/100 and a small umbilical hernia. The voided urine was grossly bloody.

On cystoscopic examination there were noted small submucosal hemorrhages around the right ureteral orifice and a block of the left ureteral orifice. A bulb ureterogram revealed a narrowed segment in the lowermost ureter with a proximal dilatation. The narrowed segment was irregular and contained a small filling defect. An excretory urogram showed right ureterohydronephrosis.

Exploration revealed an inflammatory mass surrounding the lower ureter and a T-tube was placed in the ureter. The operative course was favorable, and after the T-tube was removed an excretory urogram showed good right-sided visualization, but the hydronephrosis was unchanged.

The fistula became dry in about one month and another study by excretory urogram showed no improvement. The patient still complained of right pubic pain and the urine contained many red and white blood cells. In spite of treatment with a wide variety of antibiotics and repeated ureteral dilatation, the pain and hematuria persisted. Barium enema examination, sternal marrow aspiration, and studies of the urine for acid-fast organisms were unenlightening. A repeat biopsy at the right ureteral orifice was negative for tumor tissue.

It was then decided to treat this apparently nonspecific granulomatous inflammatory lesion with radiotherapy to the right lower ureter. A series of twelve treatments was given in a period of six weeks. Large anterior (10 × 15 cm. and 15 × 20 cm.) portals were used, and each field received 600 r (air). The tissue dose to the juxta-vesicle portion of the right ureter was estimated at about 560 r. Physical factors were: 200 kv., 20 ma., 50 cm. T.S.D., and Thoraeus filter (h.v.l. 2.0 mm. Cu).

Three weeks after x-ray treatment was begun the patient was free from pain and the voided urine became microscopically negative. Two months later the excretory urogram showed marked improvement and another study three months later was entirely normal.

Three roentgenograms.

WILLIAM J. GRIPPE, M.D.
University of Pennsylvania

X-Ray Therapy of Mongolism. Ira I. Kaplan. Arch. Pediat. **69:** 199–204, May 1952.

This paper is a preliminary report on the author's treatment of 10 cases of mongolism with x-rays. In the majority of these cases high-voltage x-ray therapy was directed to the pituitary through 3 ports, 5 cm. in diameter, frontal and right and left temporal. A dose of 100 r, measured in air, was administered to each port at each treatment at weekly intervals for four weeks. At the time of the report it was too early for the patients to have shown definite improvement.

For a further report see following abstract.

Treatment of the Mongoloid Child with Radiotherapy. Ira I. Kaplan. Radiología (Panama) **2:** 179–182, September 1952. (In Spanish)

The author quotes Benda as wondering why radiotherapy of the pituitary and other endocrine glands might not be helpful in the treatment of mongoloid infants, since such treatment has been of help in sterility. Whether or not roentgen irradiation is a stimulant to the pituitary, as it is employed in the treatment of sterile women, has not yet been determined, and it is not yet known if the same type of reaction occurs in mongoloid children treated with x-rays.

Kaplan is inclined to consider the action of the x-rays as repressive and believes that the treatment should be given as early as possible. There is apparently not the least danger of lessening the possibility of pregnancy in later years by the use of the small doses required in these children. This statement is bolstered by the fact that a patient with pituitary tumor received a total of at least 3,000 r in the pituitary fossa and yet six years later, at the age of forty years, was delivered of a normal child.

The first mongoloid child treated received six applications of 75 r on each side of the skull, measured in air. The ports were very small, just large enough for the pituitary region. The treatments were given at the rate of three a week. Although the patient remained still mentally retarded, there was notable improvement. The treatment was repeated at monthly intervals. Although the response was not spectacular, it seemed to warrant further trials. It is not yet possible to evaluate the results of the treatment in the 15 cases thus far submitted to this therapy, but they are encouraging.

JAMES T. CASE, M.D.
Santa Barbara, Calif.

Triethylene Melamine in the Treatment of Neoplastic Disease. R. Wayne Rundles and W. Bruce Barton. Blood **7:** 483–507, May 1952.

This report concerns 134 patients with malignant lymphomas, leukemia, and other neoplastic diseases treated with orally administered triethylene melamine (TEM) during a period of eighteen months. The immediate results are presented and discussed, with particular reference to the long-term management of these disorders. Triethylene melamine has an action identical to the nitrogen mustards but with the convenience of oral administration and the advantage of fewer and less severe side reactions. It must be used with great caution, however, because of its depressing effect on normal bone marrow, the range between therapeutic and toxic effects being quite narrow. The toxic effect was not cumulative; some patients were treated for months after establishment of an optimum dose.

The best results were obtained in Hodgkin's disease, malignant lymphoma, chronic lymphocytic leukemia, lymphoepithelioma of the nasopharynx and, surprisingly, in papillary cystadenocarcinoma of the ovary. Little or no benefit was obtained in acute leukemia, rapidly progressing lymphomas, multiple myeloma, and in most non-hematopoietic tumors.

The treatment was usually given in conjunction with local x-ray therapy or in situations where it was replacing total body irradiation or radioactive phosphorus. Twelve representative cases are reported in detail.

Four roentgenograms; 6 photographs; 5 graphs; 4 photomicrographs; 1 table.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

RADIOISOTOPES

Scintillation Equipment for Use in the Detection of Radioactivity in the Localization of Intracranial Lesions. Joseph F. Nechaj and Campbell Moses. J. Lab. & Clin. Med. **39:** 815–817, May 1952.

A directional scintillation counter suitable for use in the localization of intracranial lesions is described. This counter has enabled the authors to use a much smaller dose of radioactive material (50 to 100 microcuries of diiodofluorescein instead of 1 millicurie) and has provided better resolution than is possible with the conventional Geiger-Müller tube.

Two figures; 1 table.

Comparative Tests of Thyroid Function. George B. McAdams and William T. Salter. Ann. Int. Med. **36:** 1198–1205, May 1952.

In 43 patients thyroid function was appraised by four laboratory tests, in addition to routine clinical observations. The laboratory tests included determinations of (1) serum "hormonal" iodine (protein-precipitable), (2) basal metabolic rate, (3) twenty-four-hour uptake of radioiodide, (4) thyroid secretory rate, determined by the turnover of radioiodide in the gland. The chief objective was to validate laboratory means for distinguishing between hyperplasia and hyperfunction of

the thyroid in the goitrous patient. The cases studied comprised a wide range, from athyreotic and pituitary myxedema to severe primary hyperthyroidism.

It was found that the protein-bound iodine of the serum correlated well with the estimated thyroid secretory rate. Such observations are more consistent than basal metabolic rate and twenty-four-hour percentile uptake, but only when established in untreated patients. The data were found helpful in the distinction between hyperplasia and hyperfunction.

Five charts; 1 table. STEPHEN N. TAGER, M.D.
Evansville, Ind.

A Modified Radioiodine Test for Thyroid Function. Harold M. Nitowsky and Theodore T. Puck. J. Lab. & Clin. Med. **39**: 824–836, May 1952.

The authors describe a modified test of thyroid function in which the specific rate constant for I^{131} uptake is determined during the first twelve hours after administration of a tracer dose. The procedure involves multiple determinations of urinary excretion during this period, from which the specific accumulation rate by the thyroid gland is calculated by differential analysis. The values obtained are quantitatively reproducible and are subject to less error than measurements over the gland, while the procedure is sufficiently convenient to permit its routine clinical use. Results of the tests in groups of euthyroid, hyperthyroid, and hypothyroid individuals have shown good correlation with clinical estimates of thyroid activity.

The advantage of such a test in yielding a suitable parameter of thyroid function in the face of physiologic or pathologic alterations of renal function is discussed. By the administration of inert iodide after a relatively short period of urine collection, it is possible to decrease substantially the amount of irradiation which the gland would otherwise receive from the radioisotope.

Five figures; 5 tables.

A Plasma I^{131} Index for Assessing Thyroid Activity. H. Blondal. Brit. J. Radiol. **25**: 260–262, May 1952.

Measurement of the total I^{131} content of the plasma forty-eight hours after administration of a tracer dose of iodine is a fair index of thyroid activity. Samples of blood are taken two hours and forty-eight hours after administration of tracer doses of iodine, the plasma is separated, and its activity is counted. The 48/2 hour ratio in 4 thyrotoxic cases ranged from 1.75 to 2.75. In 7 cases of other thyroid diseases (cancer, non-toxic goiter, etc.) the range was from 0.05 to 0.26. In spite of the small number of cases, the author feels that this method deserves a trial, as it is simpler than measuring the thyroid uptake and gives a better separation between toxic and non-toxic states than thyroid uptake, thyroid clearance, or urinary excretion.

One graph; 1 table. SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

Serial Observations of I^{131} Levels in the Plasma as an Aid to the Diagnosis of Hypothyroidism. H. Rollman, D. W. Petit, and Paul Starr. J. Lab. & Clin. Med. **39**: 697–703, May 1952.

A comparison of the diagnostic usefulness of the twenty-four-hour uptake of I^{131} by the thyroid, of the forty-eight-hour urinary excretion of I^{131}, and of plasma levels of radioactivity was made on 36 patients (13 hypothyroid, 11 hyperthyroid, and 12 euthyroid). Both uptake and excretion studies showed a marked overlap between the euthyroid and hypothyroid patients.

In myxedematous patients there was a slower rise in levels of plasma radioactivity, and the radioactivity was lost from the plasma less rapidly than in nonmyxedematous patients. In the time periods studied, the euthyroid and hyperthyroid patients were not clearly separated by plasma radioactivity measurements.

One chart; 5 tables.

I_{131} Uptake in Treated Hyperthyroidism. Franz K. Bauer. Am. J. M. Sc. **223**: 495–501, May 1952.

Sixty patients with active hyperthyroidism or a history of past hyperthyroidism were studied by means of repeated I^{131} uptake readings.

The observations of previous investigators on the initial rapid rate of accumulation of I^{131} were confirmed.

The thyroids of treated hyperthyroid patients in remission showed a reduced total amount of I^{131} accumulation but the rapid rate of uptake persisted.

Several patients with suspected hyperthyroidism were studied and their thyroids were found to accumulate a normal maximum amount of I^{131}, but the rate of uptake was rapid.

The importance of obtaining repeated uptake readings within twenty-four hours after the administration of the tracer dose of I^{131}, particularly at three and six hours, is stressed.

Five graphs.

The Effect of Cortisone on the Iodine Accumulating Function of the Thyroid Gland in Euthyroid Subjects. Solomon A. Berson and Rosalyn S. Yalow. J. Clin. Endocrinol. & Metab. **12**: 407–422, April 1952.

The effect of cortisone on thyroid function has been evaluated by studies of thyroidal and renal plasma I^{131}-clearance rates and/or 24-hour thyroidal uptake and renal excretion measurements in 24 euthyroid subjects. Doses of 100 mg. a day or more, with a single exception, regularly produced marked inhibition of the iodine-accumulating function of the thyroid gland and usually produced an elevation of the renal plasma I^{131}-clearance rate. In almost all cases, the return to pretreatment levels was manifest within a few days to a week following discontinuation of the drug or reduction of dosage to 50 mg. a day or less. Under continued therapy the thyroid inhibition became progressively more marked, but renal clearance tended to return toward the pre-treatment level in some instances.

In general, close correlation of the iodine-accumulating function with the basal metabolism rate and the serum cholesterol concentration was not observed. It has been pointed out that significant alterations in these latter measurements may not be seen during a short course of cortisone therapy. Because alterations in renal clearance may produce spurious changes in the 24-hour uptake of I^{131} by the thyroid, the desirability of evaluating thyroid function by measurements of thyroidal plasma I^{131}-clearance rates is emphasized.

The thyroid inhibition produced by cortisone is thought to be due to pituitary inhibition, but there is no convincing proof of this hypothesis.

The possibility that hypofunction of the thyroid gland is responsible for some of the undesirable effects of cortisone therapy is suggested.

Four illustrations; 1 table.

A Case of Fatal Thyroid Crisis Occurring after Radioactive Iodine Therapy. Rodney B. Nelson, John B. Cavenagh, and Arthur Bernstein. Illinois M. J. **101:** 265–268, May 1952.

A case of fatal thyroid crisis occurring nine days after the administration of a therapeutic dose of 5 millicuries of I^{131} is reported. The patient was discharged from the hospital at his own insistence two days following treatment. When he reported to the clinic five days later, he appeared jumpy, sweaty, and moderately tachypneic, and there was a pitting edema of the ankles. He was given Lugol's solution, with instructions to take ten drops three times daily, and 1 c.c. of mercuhydrin was administered subcutaneously. He was also told to stay in bed. Approximately thirty hours later he was brought to the hospital in an irrational state, and death ensued two hours later.

In severe thyrotoxic cases careful observation and control of toxic symptoms are urged during the critical period following I^{131} administration. It is the authors' policy to place such patients on compound solution of iodine alone or with propylthiouracil. This is often necessary to control toxic symptoms during the two-week to four-month period before irradiation produces a remission. Daily observation is recommended during the critical two-week period following isotope therapy, when a dangerous exacerbation might occur. In selected cases with marked toxicity and limited cardiac reserve, preliminary control with propylthiouracil may be indicated before treatment with radioiodine.

The high grade of thyrotoxicosis in the case reported and the rapidity of its development, with thyrocardiac complications, might have led to a thyroid crisis under any therapeutic regime.

Measurements of the Disappearance of Radioactive Tagged Albumin from Serum and the Excretion of I^{131} in the Urine of Patients with Cirrhosis. Malcolm P. Tyor, Jerry K. Aikawa, and David Cayer. Gastroenterology **21:** 79–89, May 1952.

Human serum albumin is readily tagged with I^{131} and it therefore seems to be a handy tool with which to study alterations in hepatic physiology. The present study was undertaken as a part of a broad study to expand our knowledge concerning the basic physiology of portal cirrhosis and to provide more insight into liver function and the pathogenesis of ascites. Patients with cirrhosis and other diseases were studied in order to determine the rate of disappearance of tracer amounts of iodinated albumin from the vascular bed and the rate of excretion of the injected dose.

Two groups of patients were observed. One group was made up of 9 patients with cirrhosis; the other consisted of 22 persons with various diseases. Before breakfast on the day of study each patient was weighed and 10 ml. of blood was withdrawn from an arm vein. The blood furnished a blank sample for counting and was used to determine the hematocrit. Approximately 10 ml. of iodinated albumin solution (1.5 to 3 microcuries of radioactivity per ml.) was then injected and the patient was kept at bed rest for a suitable period of time for equilibration of the albumin (ten to fifteen minutes). Ten milliliters of blood was removed from a vein in the opposite arm at six, twelve, and twenty-four hours after injection. Samples were allowed to clot for one hour, then centrifuged, and 1 ml. of supernatant serum was used for counting purposes. Twenty-four-hour urine collections were made on each patient and 2 ml. aliquots of the thoroughly mixed samples were counted in the same manner as the serum.

The rate of disappearance of the tagged albumin from the blood was similar in the two groups. There was a significant decrease in the urinary excretion of inorganic iodide during the first twenty-four hours in the patients with cirrhosis. Three factors which might possibly account for this are mentioned: (1) the role of the kidney, (2) variation in the rate of metabolism of albumin, and (3) uptake of iodide ion by the thyroid in cirrhosis.

Admittedly the present study leaves much unanswered. Even so the authors advise repeated studies using iodinated albumin in a larger number of patients and with a prolongation of the sampling period. They suggest use of "load" technics and measurement of *per cent* activity of injected dose in punch biopsy specimens of the liver, in addition to possible employment of radioautography on the specimens.

Three tables. JOHN F. RIESSER, M.D.
Springfield, Ohio

The Blood Volume in Portal Cirrhosis as Determined by P^{32} Labeled Red Blood Cells. Grace M. Hyde, Nathaniel I. Berlin, Robert J. Parsons, John H. Lawrence, and Shirley Port. J. Lab. & Clin. Med., **39:** 347–353, March 1952.

The authors determined the blood volume in 28 patients with portal cirrhosis of the liver, utilizing radiophosphorus-labeled red cells. The procedure used was the original method of Hevesy and Zerahn as modified by Berlin of the Donner Laboratories, reported previously.

The authors found, contrary to studies using the Evans blue method, which revealed hypervolemia and no change in total red cell volume, that with the P^{32} method the total blood volume was extremely variable, being either high, normal, or low, and that the total red cell volume was in general normal or low. They emphasize that the total volume of red cells and plasma cannot be predicted from the hematocrit, red cell count, or hemoglobin, and that these examinations do not give the true hematologic picture. It is further pointed out that, if only these routine hematologic determinations are made, many cases of severe anemia will be considered as slight anemia and patients with a normal red cell volume may appear to be severely anemic. HERBERT D. KERMAN, M.D.
University of Louisville

The Effect of Ingested Radiophosphorus on Egg Production and Embryo Survival in the Wasp Habrobracon. Daniel S. Grosch and Robert L. Sullivan. Biol. Bull **102:** 128–140, April 1952.

Changes in the number of eggs produced per day and in their hatchability are reported for virgin Habrobracon wasps fed honey containing P^{32} in dosages ranging from the tracer level into the intermediate level of internal therapy (10 μc to 1,500 μc).

In wasps ingesting more than 200 μc/gm. of P^{32}, egg laying ceased after a period of a few days corresponding to a fraction of the supply of unresorbed ova and oocytes differentiated before treatment. The viability of the embryos from these eggs, as measured by the number hatched, is correlated with the level of activity in the material ingested. A rise in viability on the seventh to

eighth day, in experiments in which egg production continued that long, is interpreted as an indication of the lesser susceptibility of prophase eggs.

In wasps ingesting less than 200 μc/gm. of P^{32}, egg laying continued throughout life; with higher dosages, however, fewer eggs were produced. This is traceable chiefly to a decline in the eggs laid daily during the middle period of life. Curves obtained show recovery waves reminiscent of those found for cell production from rapidly dividing tissues after irradiation. Viability of the eggs produced during the first two-thirds of life is correlated with dosage. During the senescent decline in egg production, typical of both the control and the experimental group, no significant differences in hatchability were obtained.

A remarkable radioresistance was discovered, in that treated insects in all experiments lived as long as or longer than controls.

Five graphs; 5 tables.

Concerning the Distribution in the Organism of Radioactive Colloidal Gold. A. Herve and J. Closon. Schweiz. med. Wchnschr. **82:** 522–526, May 10, 1952. (In French)

Injection of radioactive colloidal gold into the peritoneal or pleural cavities should be avoided if the particles are small (about 70 Å). The material is rapidly absorbed, and distribution is similar to that following intravenous injection. The addition of an equal volume of 10 per cent gelatinous serum retards absorption and allows a more local radioactive effect.

Experience with 8 patients, 6 with ovarian and 2 with cervical carcinoma with extension, revealed no special data concerning therapeutic efficacy. However, the general irradiation effect was less in those receiving the radioactive gold-gelatinous serum mixture.

Nine illustrations, including 2 roentgenograms; 1 table.

CHARLES NICE, M.D.
University of Minnesota

Effects of Radioactive Colloidal Gold (Au_{198}) on Guinea Pigs. Edwin R. Fisher, J. C. Neering, J. B. Hazard, and R. A. Hays. Am. J. M. Sc. **223:** 502–511, May 1952.

The intraperitoneal instillation of radioactive colloidal gold, Au^{198}, in guinea-pigs produced effects similar to those of total-body irradiation. Four animals were given 4 c.c. (1 mc./c.c.), 2 animals 2 c.c., and 1 animal 3 c.c. of radioactive colloidal gold. Control animals were given 4 c.c. of non-radioactive colloidal gold. There was loss of body weight and hair in all of the animals receiving the radioactive gold. Guinea-pigs receiving approximately three to four times the lethal dose died three weeks after the instillation of the substance. The outstanding morphologic changes were focal hepatic necrosis, hypoplasia of bone marrow, myeloid metaplasia of liver and spleen, and atrophy of the testes. Animals given twice the lethal dose and sacrificed forty-nine days later showed hypoplasia and anakmesis of testes.

The maximum concentration of radioactive colloidal gold was observed in liver, stomach, and spleen, although all other organs and tissues revealed activity of minimal degree after intraperitoneal instillation. Radioactivity was distributed in the tissues chiefly in a focal manner.

Eight photomicrographs; 3 tables.

Radioautographic Studies of Sulfate-Sulfur (S^{35}) Metabolism in the Articular Cartilage and Bone of Suckling Rats. Dominic D. Dziewiatkowski. J. Exper. Med. **95:** 489–495, May 1, 1952.

Fifteen minutes after intraperitoneal administration of $sulfur^{35}$ as sodium sulfate to 7-day-old rats, the concentration of the isotope was highest in the cartilage at the epiphyseal-diaphyseal junction of long bones; it was demonstrable, however, throughout the entire epiphysis. Up to the twenty-fourth hour the pattern of deposition did not change as the concentration continued to increase.

As centers of secondary ossification developed, there occurred in them an increased concentration of some form of sulfur, insoluble as the barium salt. This sulfur was probably derived from the cartilage which the center of secondary ossification replaced.

For about thirty minutes after injection, the $sulfur^{35}$ was deposited transitorily in a high concentration in discrete loci of the bone marrow. Excluding this transitory deposition, the highest concentration of the radioisotope in the bone marrow was seen in the specimens removed twenty-four hours after injection.

In the bone shaft the $sulfur^{35}$ was deposited diffusely up to the twenty-fourth hour after its administration. Thereafter, the radioisotope decreased in concentration in the middle portion of the bone shaft. However, the concentration of a similarly characterized $sulfur^{35}$-bearing component in the ends of the diaphysis continued to increase up to at least the ninety-sixth hour after injection.

Thirty-six radioautographs; 1 graph.

EFFECTS OF RADIATION

Example of the Acute Radiation Syndrome in Man. L. H. Hempelmann. New England J. Med. **246:** 776–782, May 15, 1952.

The acute radiation syndrome is an illness produced by exposure of the entire body, or a large part of the body, to ionizing radiations of a penetrating nature. The clinical manifestations of the acute radiation syndrome are due to three characteristics of ionizing radiations. These are: their ability to penetrate matter, the selective damage that they produce in certain organ systems, and the delay in the manifestation of tissue damage.

All tissues exposed to ionizing radiation are not equally affected. For the most part tissues that proliferate rapidly, such as blood-forming organs and the intestinal and germinal epithelium, are radiosensitive. The non-growing or slowly growing tissues, such as liver and nerve cells are usually radioresistant.

Radiation produces tissue damage and death in the more radiosensitive organs of the body. The damage may not become manifest immediately but is delayed after exposure for a period of time that varies with each organ system. The clinical manifestations in a person injured by ionizing radiation are the consequence

of tissue damage, the response of the body to this damage, and factors such as infection and fluid loss, that are secondary to tissue damage.

The severity of the illness depends on the dose of radiation and the amount and location of tissue damage. However, there is a great difference in the responses of persons exposed to the same dose of radiation. Animal experiments show that some individuals of a species can survive more than twice the dose of radiation that will cause death in the most sensitive members of the same species.

The author describes radiation injuries that were received in 1945 and 1946 as a consequence of two nuclear-fission reactions that occurred inadvertently. The chain reactions took place in experimental assemblies composed of fissionable materials, and the radiations given off during the period when the reaction was uncontrolled caused the death of two persons and exposed eight others to varying doses. The radiation that caused bodily damage was a mixture of neutrons, gamma rays, beta rays, and soft x-rays.

The case histories of three persons exposed to the radiations are presented, illustrating the lethal, sublethal, and asymptomatic forms of the acute radiation syndrome.

The author has published these observations elsewhere (see Absts. in Radiology **59:** 929, 930, 1952).

Six figures. FRANK T. MORAN, M.D.
Auburn, N. Y.

The Hemorrhagic Phase of the Acute Radiation Syndrome Due to Exposure of the Whole Body to Penetrating Ionizing Radiation. E. P. Cronkite, G. J. Jacobs, George Brecher, and George Dillard. Am. J. Roentgenol. **67:** 796–803, May 1952.

The high incidence of hemorrhage not due to trauma in Japanese radiation casualties at Hiroshima and Nagasaki reveals the importance of the hemorrhagic phase of radiation injury. In the "severe cases," hemorrhage of some type was prominent and generalized purpura was common. In the Japanese patients with a hemorrhagic state there were consistent thrombocytopenia and poor clot retraction, consistent increase of bleeding and clotting times, and sporadic increase in capillary fragility. "Since there were conflicting opinions [regarding the pathogenesis of this hemorrhagic state] it was decided that a systematic study of the various hemostatic factors should be instituted in order to evaluate properly the various possible defects and to describe accurately the nature of radiation hemorrhage and its various manifestations." The study was an extensive one and encompassed many facets of the hemorrhage problem. It included the collaborative efforts of several groups of workers (Brinkhous *et al.*, Tocantins *et al.*, and the present authors). From analyzing the confirmed work it is evident that ulceronecrotic lesions and infections play a major role in initiating hemorrhage. The thrombopenic animal has difficulty in stopping the outflow of blood from eroded vessels.

From the authors' work on hemostatic mechanisms in the dog it is evident that the blood coagulation defect is directly correlated with platelet deficiency and is corrected by adding platelets *in vivo* and *in vitro*. No other agent has accomplished this. There is no good evidence for deficiency of any of the plasma factors essential for blood coagulation except those connected with the platelets.

"However, this does not rule out the possibility of other as yet unidentified factors playing a significant role in the hemorrhagic syndrome."

Three charts; 4 tables. BERTRAM LEVIN, M.D.
Minneapolis, Minn.

Further Studies on the Nature of the Hemorrhagic State in Radiation Injury. D. P. Jackson, E. P. Cronkite, G. V. Leroy, and Bernard Halpern. J. Lab. & Clin. Med. **39:** 449–461, March 1952.

In a meticulous and well controlled study, the authors investigated the hemorrhagic state occurring in severe radiation injury in dogs exposed to 600 r of whole body irradiation with a 2-million-volt x-ray machine. The investigation was designed to determine the presence or absence of circulating anticoagulants and to study the clotting mechanism following irradiation.

No conclusive evidence was found for the presence of circulating anticoagulants of the type that could be detected by Conley's test or by heparin-protamine titration tests. The only constant defect was a thrombocytopenia which was closely related to the abnormal coagulation of the blood and the spontaneous purpura. This was attributable to a clotting defect with a decrease in the number of circulating platelets, apparently as a direct result of radiation injury to the bone marrow.

Four charts; 2 tables.

HERBERT D. KERMAN, M.D.
University of Louisville

Concerning "Pyruvism" in the Course of Roentgen Therapy. M. Dobrovolskaïa-Zavadskaïa and L. Macchi. J. de radiol. et d'électrol. **33:** 237–242, 1952. (In French)

In roentgen sickness acidosis due to the accumulation of pyruvic acid plays an essential role. In avitaminosis B_1, lactic and pyruvic acids accumulate and suppress respiration of cerebral tissue. In the development of fatigue in the course of roentgen therapy a constant elevation of pyruvic acid is noted. The administration of vitamin B_1, in the form of cocarboxylase, seems to modify the metabolism of pyruvic acid, and has a favorable effect on patients with irradiation sickness.

One figure; 1 table. CHARLES M. NICE, M.D.
University of Minnesota

Radiation Injury to the Small Intestine. A Report of One Case of Massive Hemorrhage and One of Perforation Following Therapy for Carcinoma of the Cervix. Clarence E. Gardner, Jr., and William G. Anlyan. Surgery **31:** 746–749, May 1952.

It is important that the surgeon recognize that irradiation over the abdomen or through the vagina may cause intestinal ulcerations which may bleed, perforate, or cause intestinal obstruction. If any of these complications develop in a patient previously irradiated for carcinoma, hasty judgment that the carcinoma has recurred and is the cause of trouble should be withheld and the possibility of radiation injury considered until definite evidence of recurrence is established.

Two cases of radiation injury to the small intestine are reported. One patient had been given five x-ray treatments (dosage unknown) for carcinoma of the cervix thirteen and a half years previously. She subsequently received 4,400 mg. hours of intracervical and intravaginal radium and an x-ray dose of 4,500 r over four sacral and four subrapubic ports. Fol-

lowing this there were no bowel symptoms of consequence for twelve and a half years. The patient then passed several large stools of brown and red clotted blood. After a transfusion, the bleeding stopped spontaneously. Operation became necessary six months later because of continuous bleeding from the bowel of two weeks duration. A 19-cm. segment of terminal ileum containing three bleeding ulcers and an 11-cm. segment of rectosigmoid containing a similar lesion were resected and primary anastomosis was done at each site. Convalescence was uneventful, and there was no further bleeding from the bowel.

The second patient had a walled-off perforation in a necrotic segment of terminal ileum six months following x-ray and radium treatment to the cervical stump. She had first been given a total of 16,100 r, of which 3,500 r were delivered through a transvaginal cone. A month later 3,600 mg. hours of intracervical and 1,450 mg. hours of intravaginal radium were administered. Six months after this the patient complained of urinary frequency and dysuria, the passage of bright red blood from the rectum on defecation, and almost constant lower abdominal and back pain. At operation, the small bowel was found to be matted together and adherent in the pelvis, with a perforation in a 2-cm. necrotic segment of ileum. The necrotic area was resected, and an end-to-end anastomosis was done in the presence of an almost complete intestinal obstruction and gross soiling. A fecal fistula developed postoperatively, which closed spontaneously.

The treatment of the sequelae of radiation ulcerations in the small intestine is essentially the same as of any other ulcerating or obstructing process in the bowel. Resection of the damaged segment of intestine with primary anastomosis is usually the ideal procedure.

Further Experiences with an Operation for the Repair of Vesicovaginal Fistula Caused by Radiation. Victor F. Marshall and Gray H. Twombly. Cancer **5:** 429–434, May 1952.

In 1946 Twombly and Marshall described a procedure for the repair of vesicovaginal fistula due to irradiation (Surg., Gynec. & Obst. **83:** 348, 1946. Abst. in Radiology **49:** 130, 1947). The first 3 patients in whom the procedure was performed have now been followed for four and a half, five, and six years, respectively, and in each instance the fistula has remained closed and the patient has normal urinary control. The technic has since been employed in 12 patients. In 13 of the total of 15 cases the fistula has been successfully repaired, but in 2 of these secondary dissection of a residual fistulous tract was required.

The authors repeat the details of the surgical technic and report briefly 3 cases.

Seven illustrations.

Treatment of Radium Burn. Fistulae into Bladder and Rectum. A. Stuart Boyd and G. P. Charlewood. South African M. J. **26:** 400–401, May 10, 1952.

The authors report a case of associated vesicovaginal and rectovaginal fistulas due to radium which was said to have slipped out of position during treatment of carcinoma of the cervix in 1948. Repair of the fistulas, undertaken in 1951, consisted in a uterine interposition operation. The success of this type of operation depends on the fact that a peritoneum-covered organ is stitched in contact with raw surfaces and rapidly adheres, making the suture line water-tight. The procedure is recommended for the type of case described.

One drawing.

Current Concepts of Therapy of the Radiation Syndrome. Joe W. Howland. J. Missouri State M. A. **49:** 425–429, May 1952.

Exposure to whole-body irradiation does not produce signs or symptoms uniquely different from other types of injury. Six phases of the radiation syndrome are recognized: (1) shock reaction, one to two hours after exposure; (2) a latent period with no definite symptoms, lasting for four to fourteen days; (3) infection and toxicity, nine to thirty days; (4) hemorrhage, fourteen to thirty days; (5) anemia and malnutrition, twenty-four to sixty days; (6) convalescence.

The various agents and procedures which have been held to have an effect on the radiation syndrome are discussed, including agents administered prior to exposure, measures applicable at the time of irradiation, and therapeutic procedures.

The best treatment schedule is based almost entirely on supportive therapy, plus the control of complicating factors due to infection, hemorrhage, nutritional deficiencies, abnormalities in fluid and electrolyte balance, and anemia. It is obvious that none of these procedures will be markedly successful in individuals receiving more than the 100 per cent lethal dose (calculated at approximately 600 r or more). Those individuals, however, who receive less than 600 r or have partial shielding of critical areas of the body (even in the 600 r area) may be saved if certain principles in treatment are followed carefully.

Among the specific measures mentioned are complete bed rest; Aureomycin, Terramycin, or possibly Chloromycetin in clinical dosage; adequate fluid administration; bland diet; transfusions and intravenous fluid administration only when demanded by the patient's clinical condition, and then with the utmost caution; high protein and high calorie diet during convalescence, and avoidance of intercurrent infection during this period.

Experimental Radiation Cataract. II. Cataract in the Rabbit Following Single Exposure to Fast Neutrons. David G. Cogan, John L. Goff, and Elizabeth Graves. Arch. Ophth. **47:** 584–592, May 1952.

In an earlier paper on experimental radiation cataract (Arch. Ophth. **34:** 508, 1951. Abst. in Radiology **58:** 634, 1952), Cogan and Donaldson discussed the development of cataract in the rabbit following a single x-ray exposure. The study has now been extended to the production of radiation cataracts and other ocular effects in rabbits by single exposures to relatively pure neutron sources of 14 mev and fission energy.

The course of events following neutron irradiation is basically similar to that following exposure to roentgen rays, and effectivity as regards cataract production obtained with 8×10^9 neutrons/cm.^{2} (14 mev) or with 3×10^{10} neutrons/cm.^{2} is comparable to that obtained with 500 r (1.2 mev). While the morphologic changes in the lenses with neutrons and x-rays showed the same differences when heavy and when light doses were used, irradiation with 14-mev neutrons produced more of the transient vacuoles than did the x-irradiation or the fission-neutron irradiation.

The threshold dose for production of lens opacities

by neutrons is less than 2×10^9 neutrons/cm.^{2} incident on the lens.

Two charts.

Effects of X-Ray Radiation on Pancreatic Function in Dogs. Robert F. Rauch and K. Wilhelm Stenstrom. Gastroenterology **20**: 595–603, April 1952.

This study deals with the effects of irradiation on pancreatic secretion in dogs, with a view toward the temporary inhibition of pancreatic function and its practical application in abdominal surgery.

Pancreatic fistulas were made in five adult dogs after the method of Pavlov. Nutritional and electrolyte balance was maintained by a special diet, and pancreatic juice was obtained and carefully studied as to pH and enzyme activity. The dogs were then given doses of 400 or 600 r (air) to the pancreas. Enzyme studies were made on specimens collected at varying intervals up to eleven days. Additional radiation was given at varying intervals and the studies were continued. The physical factors used were 220 kv., 15 ma., 1 mm. Cu plus 1 mm. Al filter, h.v.l. 1.7 mm. Cu, 70 cm. skin-target distance, and a 10 × 15-cm. field, with the pancreas at an estimated depth of 5 cm.

The authors conclude that the most benefit derived from irradiation should come in conditions in which the enzymatic constituents of the pancreatic juice are especially harmful to the patient, *i.e.*, acute pancreatitis and injury with extravasation of pancreatic juice. They believe repeated small doses on alternate days would be best for this purpose (200 r per exposure).

There was no depression of volume of pancreatic secretion demonstrated, nor were histologic changes found in any abdominal organs, either with single exposure or repeated exposures totaling as much as 1,600 r.

Five graphs.

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Sequence of Cellular Responses to Injury in Mice Exposed to 1,000 r Total-Body X-Radiation. Jack Barrow and John L. Tullis. Arch. Path. **53**: 391–407, May 1952.

Eight hundred and eighty mice, in groups of 150 to 200, were exposed to the angular beam of x-rays at 1-meter distance from the tube. The physical factors were: 1,000 kv., 3 ma., no added filter, 2.2 mm. of lead h.v.l., 31.23 r per minute (in air), 35.1 minutes exposure. An absolute lethal dose of 1,100 r was administered to ensure death and thus increase the likelihood of uniform response in the tissues of all animals. Beginning at one hour after irradiation and continuing at hourly intervals up to eighty-eight hours, mice were killed, 10 at a time, with carbon dioxide. Autopsies were performed immediately after death.

Pathological changes were found in the spleen, lymph nodes and intestinal lymphoid tissue, bone marrow, the small and large intestine, and the testes. No significant changes were observed in the liver or the lungs.

On the basis of their studies, the authors conclude that there is little difference in the degree to which lymphoid tissue is sensitive to a single exposure of total-body irradiation, whether the tissue be in the spleen, the lymph nodes, or the intestinal lymphoid aggregations.

No deleterious effect on the cells of the reticuloendothelial series were observed.

Of the hematopoietic tissues, the erythropoietic series appears to be most sensitive to the effects of ionizing radiation, the granulocytic, or myelopoietic, series next, and the megakaryocytes next. These are all exceeded in sensitivity by the lymphocytes.

The intestinal crypt epithelium of the mouse is quite radiosensitive but has striking regenerative powers. The radiosensitivity of the epithelium of the small intestine is somewhat greater than that of the epithelium of the large intestine.

Of the cells of the testis, the spermatogonia seem to be most radiosensitive, and those with dust-like nuclei (the earlier forms) somewhat more sensitive than those with crust-like nuclei. This may be only apparent and due to the fact that the former naturally mature into the latter. In any event, the still earlier or more primitive basement membrane cells seem to be relatively radioresistant.

Twenty photomicrographs; 3 charts.

Alteration of the Mortality of Roentgen Irradiated Mice by Chemical Means. George Limperos. Am. J. Roentgenol. **67**: 810–816, May 1952.

This paper lends further evidence to the indirect mechanism theory for the action of roentgen irradiation *in vivo*. The action of radiation is felt to be due in part to the highly active free radicals (OH, H, HO_2, etc.) generated from cellular water. Therefore, the action of agents capable of influencing the production of these radicals was studied. These include sulfhydryl compounds (cysteine, glutathione, thiourea), sulfhydryl inhibitors, and oxygen.

Thiourea, when injected intraperitoneally in doses up to 4,000 mg./kg. before roentgen irradiation, was found to decrease significantly the mortality of mice irradiated with 450 r, 500 r, and 600 r. Thiourea injected after irradiation offered no protection. When folic acid was injected at the same time as thiourea and administered in the drinking water after irradiation, the protective effect of thiourea was diminished. Injecting sodium maleate before irradiation increased the mortality of the mice. Perhaps the sulfhydryl-containing constituents of the tissues were lowered by interaction with this salt.

The susceptibility of mice to roentgen irradiation could be altered by changing the oxygen tension. A 10 per cent oxygen concentration during irradiation decreased the mortality of mice, whereas a 100 per cent oxygen concentration increased the mortality to a slight degree. It is felt that a reduced oxygen tension decreases the formation of OH and HO_2 radicals as well as H_2O_2; an increased tension increases the effects of irradiation probably by increasing the activity of the OH radicals and by increasing the production of HO_2 radicals and H_2O_2.

Seven tables.

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Testosterone Prevention of Post-Irradiation Lymphomas in C57 Black Mice. Henry S. Kaplan and Mary B. Brown. Cancer Research **12**: 445–447, June 1952.

In an earlier investigation it was found that testosterone strikingly inhibits radiation-induced lymphoid tumor development in intact and castrate adult male C57 black mice (Cancer Research **11**: 706, 1951. Abst. in Radiology **59**: 315, 1952). Two additional experiments have now been carried out, revealing that (*a*) testosterone inhibits lymphoma development only

when given concurrently with irradiation and (*b*) that the inhibitory effect of testosterone previously noted in male mice of this strain is also observed in females, the degree of inhibition being apparently somewhat greater in spayed than in intact animals.

One chart; 2 tables.

Protection Against Radiation-induced Lymphoma Development by Shielding and Partial-Body Irradiation of Mice. Henry S. Kaplan and Mary B. Brown. Cancer Research **12:** 441–444, June 1952.

It has been previously shown (J. Nat. Cancer Inst. **12:** 427, 1951. Abst. in Radiology **59:** 478, 1952) that lymphoid tumors, which are readily induced by whole-body irradiation of C57 black mice, occur infrequently when the treatment is localized to an area of one-half the body or less or when a lead shield is placed over a peripheral region such as the thigh or lower extremity during irradiation. Although repeated irradiation of either half of the body alone is ineffective, alternate irradiation of the upper and lower halves of the body has yielded about the same lymphoma incidence as whole-body irradiation when the interval between exposure of the two halves of the body was twenty-four hours or less. The present report is based upon two additional experiments concerned with these phenomena.

Experiment I: Alternate half-body irradiation of C57 black mice yielded a maximal lymphoma incidence when the interval between treatment of the two body halves was twenty-four hours, decreasing gradually thereafter through eight days. Response was largely abolished when animals were irradiated first over the upper half of the body for four consecutive treatments and then similarly over the lower half of the body.

Experiment II: Lymphoma incidence was strikingly reduced by shielding the thigh, lower extremity, or lower abdomen, but not by shielding of the tail during irradiation. There was a suggestive relationship between the volume of tissue shielded and the degree of protection. Incidence was restored to normal high levels when the lower extremities were shielded initially and then locally irradiated either immediately or at an interval of twenty-four hours. There was no inhibition when a different extremity was shielded at each of four successive exposures.

One chart; 2 tables.

Effect of Radiation on Transplantable Mouse Tumor Cells. M. C. Reinhard, H. L. Goltz, and S. G. Warner. Cancer Research **12:** 433–437, June 1952.

Using the technic described in an earlier paper (Cancer Research **5:** 102, 1945), the authors studied the effect of x-radiation on mouse tumor cells in suspension: first, to establish the lethal effect of equal doses of radiation on different concentrations of tumor cells; second, to determine the influence of radiation on the growth period; third, to determine whether any radiation effect would be transmitted to a second transplant generation; and fourth, to determine the lethal effect of other doses of radiation delivered to the tumor cell suspensions.

For the preliminary exposures, doses of 3,600 r were used, that being the 50 per cent lethal dose for tumors irradiated *in vivo*. Cell suspensions subjected to this dose, however, produced no growth in inoculated animals. Subsesequent exposures showed that 500–1,000 r permitted growth in a sufficient number of animals so that both the percentage of takes and the growth period could be determined.

The destructive effect of a dose of 500 r on viable tumor cells in suspension, obtained by comparing the number of viable cells in an irradiated suspension with those in an untreated suspension producing the same percentage of takes, was found to increase with decreasing concentration of viable cells.

The radiation acts on those cells which survive, either to produce a lower growth rate or a period of dormancy of several days followed by a normal growth rate. The fact that tumors arising from an irradiated suspension fail to show any carry-over of the effects of radiation on either the percentage of takes or the growth rate, into the second transplantation, lead the authors to favor the latter suggestion.

The Treatment of Postirradiation Infection with Antibiotics. An Experimental Study on Mice. C. Phillip Miller, Carolyn W. Hammond, Marianne Tompkins, and Gertrude Shorter. J. Lab. & Clin. Med. **39:** 462–479, March 1952.

Previous experiments by the authors have resulted in the observation that severe bacteremia, amounting to an overwhelming sepsis, occurred in a large proportion of mice during the second and third weeks after irradiation. They now report a study of the protective action of antibiotics in the treatment of postirradiation infection.

Young adult mice of three different strains were subjected to total body x-irradiation in a single exposure, with dosage varying from 450 to 600 r.

Streptomycin was the most effective of the antibiotics used. The addition of Penicillin to Streptomycin failed to improve the therapeutic effect. The next most beneficial drugs were Chloramphenicol, Aureomycin, and Terramycin. Combinations of three or more antibiotics were no better than an individual drug. Neomycin was ineffective. Polymycin proved to be toxic.

The effectiveness of Streptomycin seemed to persist throughout the course of treatment, which ordinarily lasted for as long as three weeks. Although the superiority of Streptomycin to the other antibiotics was anticipated, it seemed surprising that its effectiveness persisted for so long a time, since bacterial resistance to Streptomycin is thought to develop very rapidly. The drug was somewhat toxic in the doses used.

In the untreated control mice there was a great variation in mortality due apparently to a high incidence of infections with *Proteus*, *Pseudomonas*, or *Salmonella*.

The authors have emphasized the fact that none of the antibiotics used was ideal. They were incapable of controlling infection with most strains of *Pseudomonas* and many strains of *Proteus*.

The study emphasizes the importance of infection as a lethal factor in mice exposed to moderate doses of total-body irradiation.

Six charts; 7 tables.

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Plasma Proteins and Plasma Volume in Rats Following Total-Body X-Irradiation. Helen Supplee, James D. Hauschildt, and Cecil Entenman. Am. J. Physiol. **169:** 483–490, May 1, 1952.

Preliminary studies by the authors showed that in

rats receiving 400 to 800 r total-body irradiation the plasma protein concentration is decreased, beginning about the third day. This decrease could result from (*a*) decreased plasma protein synthesis, (*b*) increased plasma protein utilization, or (*c*) dilution because of increased plasma volume. In the present investigation the last factor was studied. Simultaneous measurements were made of plasma protein concentrations and plasma volume in rats for as long as twenty days after total-body irradiation (250 kv.p.; 15 ma.; filtration 0.5 mm. Cu and 1 mm. Al; target skin distance 40 inches; rate 25 r per minute).

In rats given 750 r, the plasma volumes, expressed as milliliters per 100 gm. final body weight, decreased to values 20 per cent below the controls by the third day. No decrease was observed in the animals given 400 or 600 r. Plasma volumes then increased in all irradiated rats. On the fourteenth day, rats exposed to 400, 600, or 750 r had plasma volumes 15, 47, and 45 per cent higher than their respective controls.

The plasma protein concentration of rats exposed to 600 and 750 r had decreased to 20 per cent below the control values at the end of the experimental period.

The total circulating plasma protein was found to decrease during the first week after exposures to 600 and 750 r, and to increase to levels well above the controls during the second week after all exposures given.

Four charts; 2 tables.

Effects of Dietary Protein and Methionine on the X-Irradiated Rat. Willie W. Smith, Isabelle B. Ackermann, and I. M. Alderman. Am. J. Physiol. **169:** 491–498, May 1, 1952.

Rats maintained before and after irradiation on diets containing 6 per cent casein showed a slightly higher incidence of death after irradiation with 550 r than did rats on 18 and 35 per cent casein diets. Irradiation factors were: 200 kv., 20 ma., 0.78 mm. Al and 0.25 mm. Cu added filtration, distance 75 cm. Reduction of the casein content of the diet after irradiation did not significantly alter forty-day mortality.

When casein was increased to 60 per cent, the observed mortality was somewhat reduced, but the difference was not statistically significant. Addition of methionine and cystine to the low-casein diets did not influence the incidence of death.

The effect of radiation on depression and recovery of leukocyte and erythrocyte production was not greatly influenced by diet, but a slight delay in reduction of circulating reticulocytes was observed in the 35 per cent casein diet group. The average rate of oxygen consumption by nembutalized rats on a 6 per cent casein diet was 12 per cent below, and on a 60 per cent casein diet 18 per cent above, the value for rats on the 18 per cent casein diet.

Four charts; 4 tables.

Effect of X-Radiation, Radiomimetic Substances and Surgical Trauma on Sulfhydryl Content of Plasma. Bernard Shacter, Helen Supplee, and Cecil Entenman. Am. J. Physiol. **169:** 499–507, May 1, 1952.

Exposure of rats to 700 r total-body irradiation was followed after several days by a marked decrease in the sulfhydryl content of the plasma. The irradiation factors were: 250 kv.p.; 15 ma.; 0.5 mm. Cu plus 1 mm. Al filter; half-value layer 1.5 mm. Cu; target-skin distance 102 cm.; 25 r (in air) per minute. A similarly delayed decrease, of lesser magnitude, was observed after administration of nitrogen mustard and trisethylene triazine at a dose level of 1 mg. per kilogram body weight. No well defined plasma sulfhydryl changes were detected during a six-day period of starvation or after exposure of rats to 300 r total-body irradiation. Surgical trauma induced by laparotomy led to a significant decrease in plasma sulfhydryl levels by twenty-four hours after injury, followed by a linear return to normal values over a twelve-day period. No significant changes in plasma sulfhydryl levels occurred during the first twelve hours subsequent to laparotomy.

Since the initiation of plasma sulfhydryl changes in the present experiments and acceleration of tissue mitotic activity in similar conditions seem to occur in parallel, it is suggested that decreases in plasma sulfhydryl levels following tissue injury may be indicative of a markedly increased rate of utilization of sulfhydryl groups by regenerating tissue.

Two charts; 3 tables.

Effect of X-Radiation and Laparotomy on the Polysaccharide Content of Plasma: Relationship to Plasma Sulfhydryl Changes. Bernard Shacter, Helen Supplee, and Cecil Entenman. Am. J. Physiol. **169:** 508–510, May 1, 1952.

Following a single exposure of male rats to 700 r total-body x-irradiation, there was no change in the polysaccharide content of the plasma for the first five days. On the sixth day, however, the plasma polysaccharide rose significantly; it remained elevated for a few days and was back to normal by the twelfth day. Exposure of rats to 300 r total-body irradiation had no effect on plasma polysaccharide levels.

Laparotomy, performed on equal numbers of male and female rats, resulted in a rapid change in plasma polysaccharide content, a significant increase being apparent twenty-four hours after surgery. The highest polysaccharide levels were attained one to two days following laparotomy and they then returned gradually toward normal. No changes in plasma polysaccharide concentrations were observed in male rats during the first twelve hours after laparotomy.

Plasma polysaccharide concentrations were consistently greater for male control and laparotomized rats on each test day than for the corresponding female animals. The over-all mean value of 36.4 mg. polysaccharide/gm. protein, obtained in 16 male control rats, was significantly greater, at the 1 per cent level, than the 32.0 mg./gm. protein obtained on 16 female control rats.

Two tables.

Some Cytologic and Histochemical Studies of Radiation Reaction. Shields Warren, Margaret W. Holt, and Sheldon C. Sommers. Am. J. Clin. Path. **22:** 411–417, May 1952.

Cytologic and histochemical investigations of frozen-dried dry-mounted animal tissues exposed to ionizing radiations are reported. In radiosensitive cells prominent intranuclear vacuoles developed, with lethal rupture of nuclear membranes. Radioresistant cells remained viable and formed small intranuclear vacuoles that were extruded. Stains for desoxyribose nucleic acids showed postirradiation loss proportional to radiosensitivity. Among four so-called radiomimetic chemicals tested (aminopterin, urethan, nitrogen mustard,

and colchicine), only cholchicine closely simulated the effects of radiation.

Ten photomicrographs.

Evidence for a Humoral Factor (or Factors) Concerned in Recovery from Radiation Injury: A Review. Leon O. Jacobson. Cancer Research 12: 315–325, May 1952.

A brief review of data is presented which shows conclusively that survival of laboratory animals exposed to a single lethal dose of total-body x-irradiation can be significantly increased by measures instituted after the radiation injury has been sustained. These measures involve spleen-shielding, intraperitoneal implantation of splenic tissue and of embryo suspensions, intravenous or intraperitoneal injection of homologous bone marrow suspensions, and related technics. The evidence presented indicates that the factor (or factors) responsible for recovery from radiation injury under these conditions is likely a humoral (non-cellular) substance (or substances) produced by the living cells of the shielded, implanted, or injected tissue, that is capable of instituting recovery of certain tissues of the body vital to survival. If further experiments indicate that heterologous transplants or injections of tissue suspensions are effective, the possibility of seeding or colonization by cells of the shielded or implanted tissue as a factor in the reconstitution of the depleted blood-forming tissues is reduced to one of secondary importance for the purposes of this discussion. It is admitted, however, that a possibility exists that the shielded or implanted tissue may produce its effect by some detoxification process.

The identity of the humoral factor (or factors) under discussion is as yet unknown. Nor is it known from which cells of the body the factor originates. It is produced or made available in an effective quantity by minute amounts of hematopoietic tissue or so-called reticulo-endothelial tissue, whereas larger quantities of tissue such as kidneys have thus far proved ineffective. With the assay methods now in use, living cells appear to be necessary in the material administered to alter effectively the radiation syndrome and promote recovery. It is firmly established that the factor (or factors), when made available to irradiated animals, brings about an early recovery of the blood-forming tissue. This recovery may be directly as well as indirectly responsible for the enhanced survival of irradiated animals. It may be that the factor (or factors) is involved in the orderly regeneration or functional reconstitution of yet other cells, tissues, or organ systems of the body which are important, if not vital, to survival of the irradiated animal.

The implication of these findings for problems of radiation injury and radiation therapy are obvious, but their application to medicine in general, and to neoplastic and non-neoplastic diseases of the blood-forming tissue in particular, requires exploration.